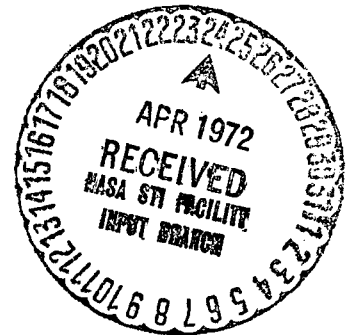


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CAT 34

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3-71	WHITE, Michael	"Top Management and Management Science"	Feb. '71	14s
6-71	RADNOR, Michael & TANSIK, David	"An Organization Theory Perspective on the Development of New Organizational Functions"	Mar. '71	24
8-71	WHITE, Michael	"Analysis versus Bargaining"	Apr. '71	12s
9-71	VERTINSKY, Ilan & BARTH, Richard	"A Model of Diffusion and Implementation: An Exploratory Study of Managerial Innovation in Columbia"	Feb. '71	28
10-71	BARTH, Richard T. & VERTINSKY, Ilan	"A Community Study of Organizational Form and Managerial Innovation in a Developing Region"	1971	53
12-71	WHITE, Michael	"A Brief History of the Cooperative International Program"	May, '71	3

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PATTERNS IN THE DEVELOPMENT OF OPERATIONS RESEARCH  
AND MANAGEMENT SCIENCE ACTIVITIES IN GOVERNMENT

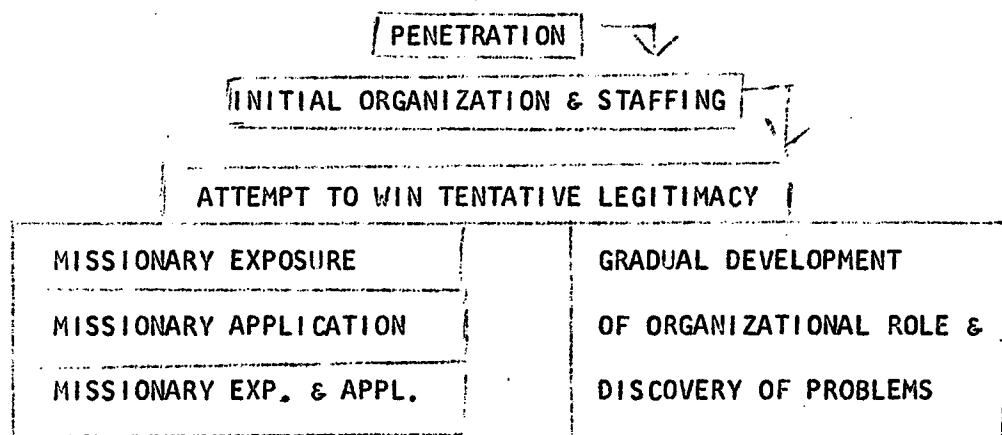
Michael J. White

This introduction is compressed because this paper is actually the second part of a longer paper, the latter becoming available in the near future (White thesis, 1971a).

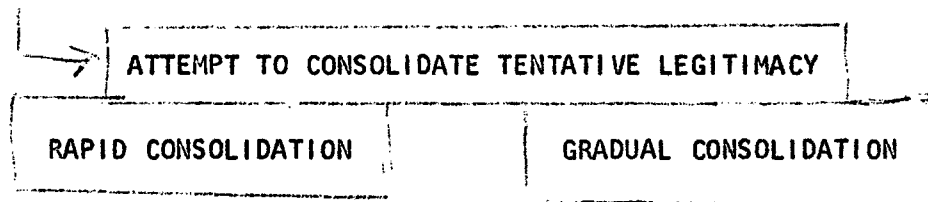
Basically, and briefly, we can conceive the development of an operations research or management science (OR/MS) activity in an organization as occurring in a series of phases. These phases have been derived from field experience, from evaluation of previous studies of OR/MS activities, and from well-known theories of innovation or behavior change. Of the latter, Rogers' (1963) five stage model of the adoption of innovation is particularly suggestive, with its notion of trial and adoption. And, the Lewinian model of unfreezing - change - refreezing is also important. Prior research on OR/MS refers specifically to work by Rubenstein, Radnor, et. al., (1967) and by Radnor, Rubenstein, and Bean (1968). This literature is discussed in my thesis (White, 1971a).

The first phase is one of Penetration and Initial Organization of the OR/MS activity. This is the period during which managers in the organization learn about OR/MS, consider initiating an OR/MS

activity in their organization, and proceed to do so. Following this, there is a phase which might be called a trial period or unfreezing period. Instead it is here called Attempt to Win Tentative Legitimacy. In this period, the new OR/MS staff, through the efforts of its analysts, attempts to win from managers a trial of their new technology and of themselves as new organizational actors. We are assuming here that in general, the new activity, is not welcomed with open arms, or even, in general, with tolerant skepticism. Rather, some tentative legitimacy must be earned by the staff. There are two ways to go about this, through aggressive or Missionary activity, and through passive or gradual activity. In the former case, the OR/MS staff may be Missionary in the way they "sell" OR/MS, or in how they apply it, or in both. Alternatively, OR/MS may try to gain tentative legitimacy by gentler persuasion, by staying closer within the boundaries of the possible, and by avoiding creating threat. The phase, Attempt to Win Tentative Legitimacy has, then, two subphases, a Missionary and a Gradual subphase. The model so far is illustrated below.



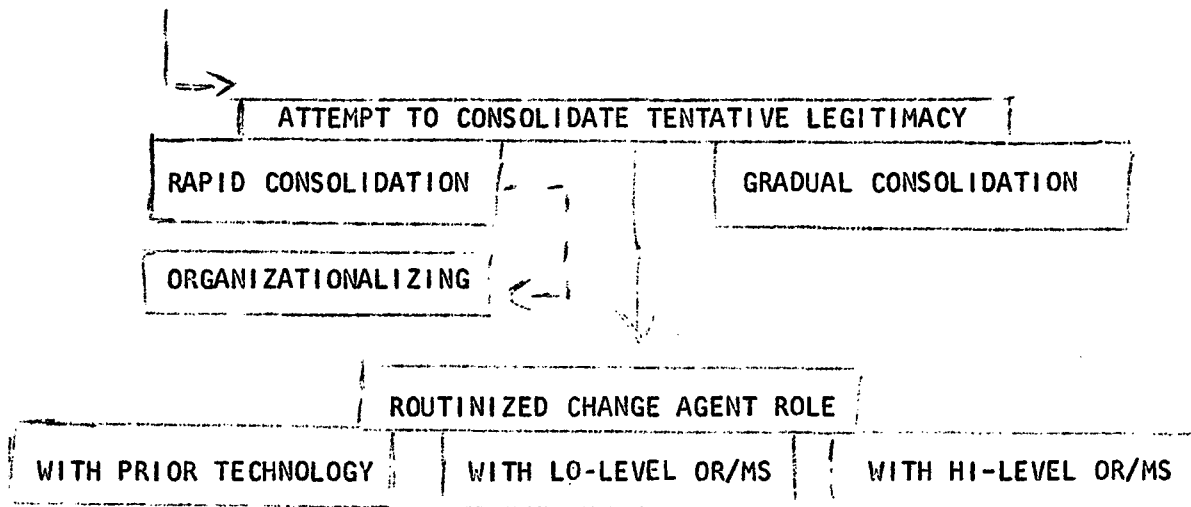
Assume that after a while, the managers in the organization have toward the OR/MS activity an attitude that can be considered a grant of Tentative Legitimacy. The next phase for the OR/MS activity is to "cash in" on this, to consolidate this tentative legitimacy. They do this through their performance of projects and other work. If their work is useful to managers, the trial becomes an adoption, the unfrozen manager becomes changed, the legitimacy is Consolidated. The next phase is called, then, Attempt to Consolidate Tentative Legitimacy. Again, this can be divided into two subphases, one involving aggressive OR/MS activity and the other involving a more passive orientation.



Missionary and other aggressive behavior tends to occasion substantial resistance in the organization. If the missionary OR/MS analysts are not socially skilled, or if the organization does not have a pressing need for their services, there may be a "counter-revolution" in which the OR/MS activity is discontinued or changed radically. This occurs during a phase which I have called Organizationalizing, a term which refers to the fact that in this period, the OR/MS activity is forced to adapt to organizational needs, values, priorities, expectations, etc. Usually in this phase, some of the best professionals leave, project selection is severely

circumscribed, and the leader of the activity is replaced. This phase, which rarely lasts for more than three months, results in a change in the character of the activity; it usually becomes less aggressive. Organizationalizing is a phase that follows the Missionary or the Rapid Consolidation phases.

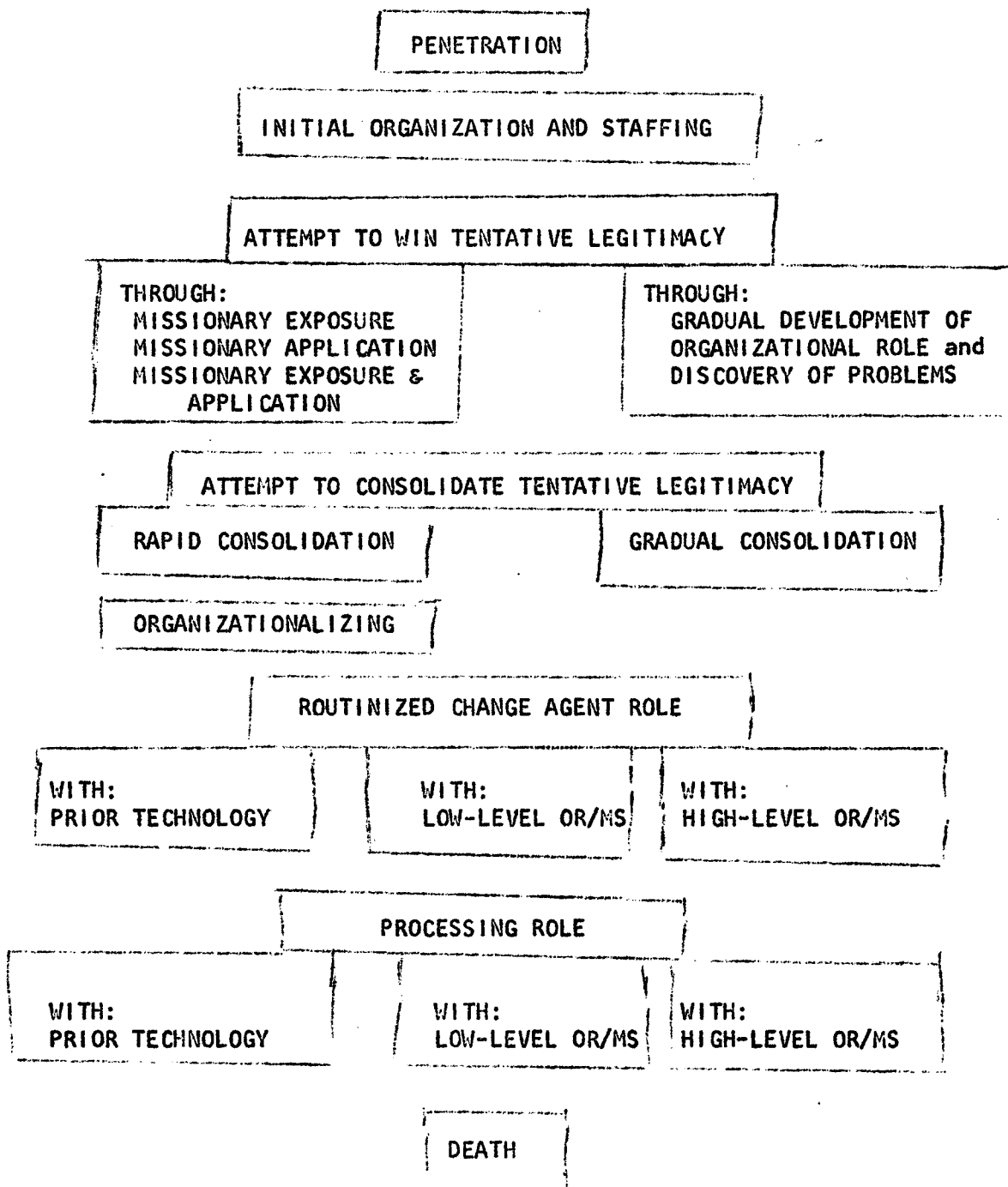
If the activity is able to consolidate the tentative legitimacy it has obtained, it moves into a new phase. We call this phase the Routinized Change Agent phase. This refers to the fact that the organizational mission of OR/MS involves, among other things, the routine production of new ideas and intelligence. In other words, the OR/MS activity, when accepted in the organization, is a change-agent function. But it is not just a change agent on an occasional basis; it is a change agent as a routine part of its mission. We can define the success of an OR/MS activity as a state in which the activity is applying OR/MS technology to management problems in a Routinized Change Agent Role. This Routinized Change Role is the next phase. For purposes here, it can be divided into three subphases: (1) the application of hi-level OR/MS; (2) the application of Lo-level OR/MS; and (3) the application of some prior, more conventional technology in a change agent role.



Finally, it is possible that after a period of time in the Routinized Change Role phase, an OR/MS activity may find itself no longer performing innovative work. Instead, they operate and update models which have already been constructed, programmed, and tested. In a sense, the activity is processing work already completed. This may occur because the key professionals leave, or because critical problems amenable to OR/MS have been solved. Whatever, there is a Processing phase in which work is being done, but innovation is not taking place. Here, the staff is accepted, but it is not producing much change. Again, there is a need to distinguish subphases. The same three subphases that were offered for the Routinized Change Role phase are applicable here.

As a code, it is necessary to have some name for what happens when an OR/MS activity is disbanded. Here, that will be called a Death phase. The full list of phases is illustrated in Figure 1 below. There are innumerable paths through these phases. It is not necessary to explore them here. Many will be illustrated when specific OR/MS activities are discussed.

Figure 1





Thirty-three federal civilian agency OR/MS groups have been coded into these phases. The coding procedure is complex, and has several stages. Unstructured interviews have been conducted and documents collected at each of the thirty-three sites for as much as four years. The interview transcripts and the documents have been coded and verified by the author and an associate into a five variable scheme. These codings are done by quarter-year periods, and some interpolation has been necessary where data is scanty. Then, the first-stage codings are mapped into the phases just outlined by an algorithm. The five-variable scheme and the second-stage algorithm are reproduced in Figures 2 and 3 below.

FIGURE 2

THE FIVE-VARIABLE SCHEME

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LEGITIMACY	None	Tentative	Consolidated
AGGRESSIVENESS	Aggressive Missionary	Passive	Routinized Relations
INNOVATIVENESS	Slightly	Moderately	Highly
SKILLS	Low	Medium	High
TECHNOLOGY	Prior	Low-Level	High-Level

---

Prior analysis had led the author to expect that there would be two common paths through the phase diagram, a Revolutionary Pattern and an Evolutionary Pattern (these terms will be defined precisely shortly). The reason for the coding process, then, was to try to

TABLE FOR SECOND STAGE OF CODING

Figure 3.

	skills	technology	Innovativeness to	legitimacy	aggressiveness
ATTEMPT TO WIN TENTATIVE LEGITIMACY: EVOLUTIONARY (Development of organizational role and discover problems)	Low, Medium, High	Prior or Low-level	Slightly to Moderately	None	Passive
ATTEMPT TO WIN TENTATIVE LEGITIMACY: REVOLUTIONARY (Missionary Exposure)	Low, Medium or High	Prior	Slightly	None	Aggressive
(Missionary Application)	High or Medium	High-level or Low-level	Slightly or Moderately	None	Aggressive
(Missionary Application and Experience)	High or Medium	High-level or Low-level	Highly or Moderately	None	Aggressive
ATTEMPT TO CONSOLIDATE LEGITIMACY: EVOLUTIONARY (Gradual Consolidation)	High, Medium, or Low <sup>2</sup>	Low-level	Moderate or Slight	Tentative	Passive
ATTEMPT TO CONSOLIDATE LEGITIMACY: REVOLUTIONARY (Rapid Consolidation)	High or Medium	High-level or Low-level	Moderately to Highly	Tentative	Aggressive
ROUTINIZED CHANGE-AGENT ROLE (Prior Technology)	Low, Medium or High	Prior	Slightly <sup>4</sup>	None, most likely, but possibly Tentative or Consolidated <sup>3</sup>	Routinized
(Low-level OR/MS Technology)	Medium or High	Low-level	Moderately or Highly	Consolidated	Routinized
(High-level OR/MS Technology)	High	High-level	Highly or Moderately	Consolidated	Routinized
PROCESSING ROLE <sup>5</sup> (Prior Technology)	Low, Medium or High	Prior	Slightly	None; possible Tentative <sup>6</sup>	Passive
(Low-level Technology)	Medium or High	Low-level	Slightly	None or Tentative or High	Passive
(High-level Technology)	High or Medium	High-level	Slightly	None or Tentative or High	Passive

(footnotes omitted)

discover as objectively as possible the incidence of these two patterns. To the extent that the two patterns are frequent and distinct, then managers of new change-producing functions may be able to gain a better perspective on these functions.

#### A DIGRESSION ON THE NATURE OF THE SAMPLE

Before discussing the progress of OR/MS in federal civilian government, it is necessary to clarify the nature of the sample of thirty-three OR/MS groups. There is no pretension that these are all the OR/MS groups in federal civilian agencies. The question is, rather, to what extent do observations based on these thirty-three groups lend meaningful insight into the progress of OR/MS in civilian government at the federal level.

There are departments where the author has done little work, and the Defense/Space/Foreign Affairs complex has, because of its secrecy, been ignored. Civilian agency OR/MS groups which work on hardware or equipment problems rather than management problems have also been avoided, though the author knows of several. There are also some staffs working on economic problems whose activities would probably meet our criteria for OR/MS; some of these staffs have been in existence for many years. Their birth pangs and development problems are usually too far in the past for this research to capture. In spite of these qualifications, the thirty-three groups studied here should present a reasonably accurate overall picture of the development of

OR/MS in federal civilian government.

These groups were discovered through contacts with officials of local Washington-area professional societies, through officials of government agencies in a position to have an overview of such activities, through "snow-balling" with existing contacts, and through perusal of the Government Organization Manual, Congressional Directory, and conference programs of key professional societies (ORSA, TIMS). While many staffs seem to the distant observer to be likely locations of OR/MS activity, this is often not the case. There are a number of "leads" which when followed up did not eventuate into field sites. In terms of formally organized in-house OR/MS, the author feels confident that his sample of thirty-three groups is adequate to support the conclusions he will draw.

However, the underlined words bear the crucial qualification. Much OR/MS work takes place in either of two forms: (1) contract research, and (2) ad-hoc teams. (1) Contract research is particularly common for large-scale program evaluation, and in policy areas where the necessary infra-structure of consulting contractors exist (e.g., transportation). Where the contracts are developed through "RFP's" and monitored by a single staff in an agency, that staff may develop into what is here considered an OR/MS staff ( numbers 4 and 37, for example). But also there may be less focused contracting in an agency -- contracts are drawn up for specific purposes or problems and performed for administrators who do not use OR/MS in any routinized fashion.

Such activity is not covered here. (2) The same ~~diffusely~~ **organized** OR/MS may be performed by in-house personnel. Agencies with high percentages of mathematically-trained professionals (power engineers, for example) may routinely perform OR/MS analyses, yet have no formally-organized OR/MS staff. It is not clear how much OR/MS activity takes place in these less organized forms. The author suspects that it equals the amount that is formally organized given the tendency for "government by contract" noted by Don K. Price (Price, 1964) and the large number of people in departments like Interior, Transportation, or Agriculture who are capable of performing at least elementary OR/MS studies. These less organized forms present different behavioral problems, however. For example, with no formal organizational entity, problems of status and power competition are much more diffuse.

Given these qualifications, that the discussion here involves only formally organized, in-house OR/MS staffs, some possible objections to the conclusions may be obviated.

#### REVOLUTIONARY AND EVOLUTIONARY PATTERNS

Revolutionary and Evolutionary patterns are distinguished by the phases they include. For a group to be classified into the Revolutionary pattern, it must pass through a Missionary phase and/or a Rapid Consolidation phase, and must **not** pass through either of the corresponding phases of Gradual Consolidation or of Development of Organizational Role; for a group to be classified into the Evolutionary

pattern, the group must pass through either or both of the latter phases but cannot pass through either of the former phases. This still, in each pattern, leaves a number of possibilities open -- some are illustrated in Figure 4 (for the Revolutionary pattern) and Figure 5 (for the Evolutionary pattern). When an activity passes through phases characteristic of both major patterns, this will be called a mixed pattern. Some simple mixed patterns are indicated in Figure 6; more complex actual ones are shown later. These figures present only the connecting arrows necessary to illustrate the patterns.

The first substantive question is, then, how many of the government OR/MS groups actually can be classified into Revolutionary or Evolutionary patterns? Figures 7 through 13 present the data for the answer. Figures 7 and 8 give the actual patterns of those groups which are classified as Revolutionary. The two figures distinguish between groups which begin their Revolutionary pattern in the Missionary phase and those which begin (after initial organization) in a Consolidation phase. There are only two of the total of thirty-three groups which show a Revolutionary pattern and which start with a Missionary phase (Figure 7). \*\* These groups, which have been assigned the file

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\*\* Currently, thirty-three federal civilian agency OR/MS groups have been coded according to the procedures outlined earlier. More groups than this have been investigated, and some new ones are currently being added to the site sample. Those that have been studied and are not included, however, are groups which never got off the ground doing OR/MS work. In addition, it should be noted that in presenting the patterns of these thirty-three groups, a slightly different phase diagram is being employed. In this diagram, the phase of Initial Organization is expanded into sub-phases. For convenience, however, only one is used. This alternative phase diagram makes the presentation of the patterns of individual groups easier.

FIGURE 4: Examples of Revolutionary Patterns

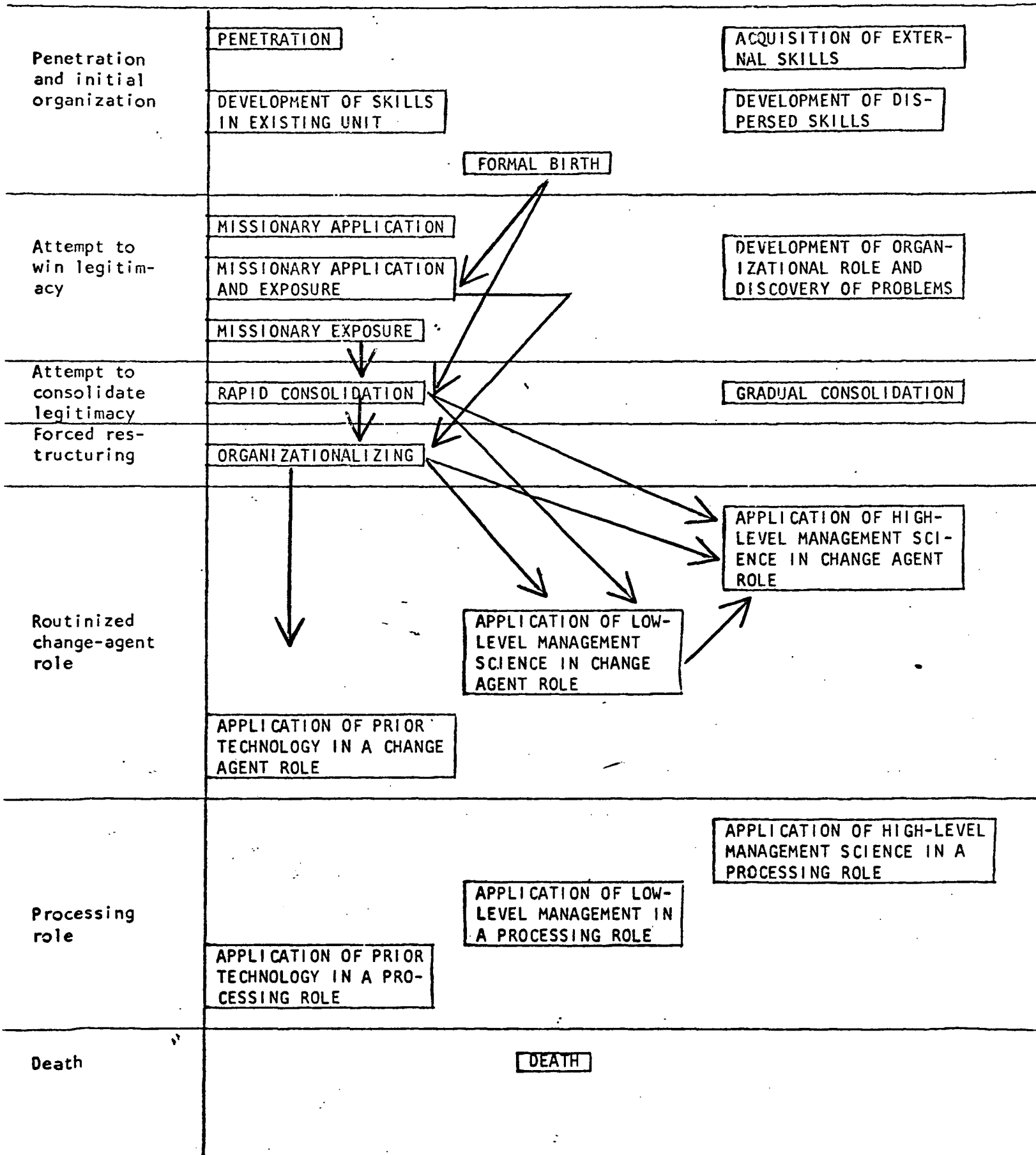


FIGURE 5: Examples of Evolutionary Patterns

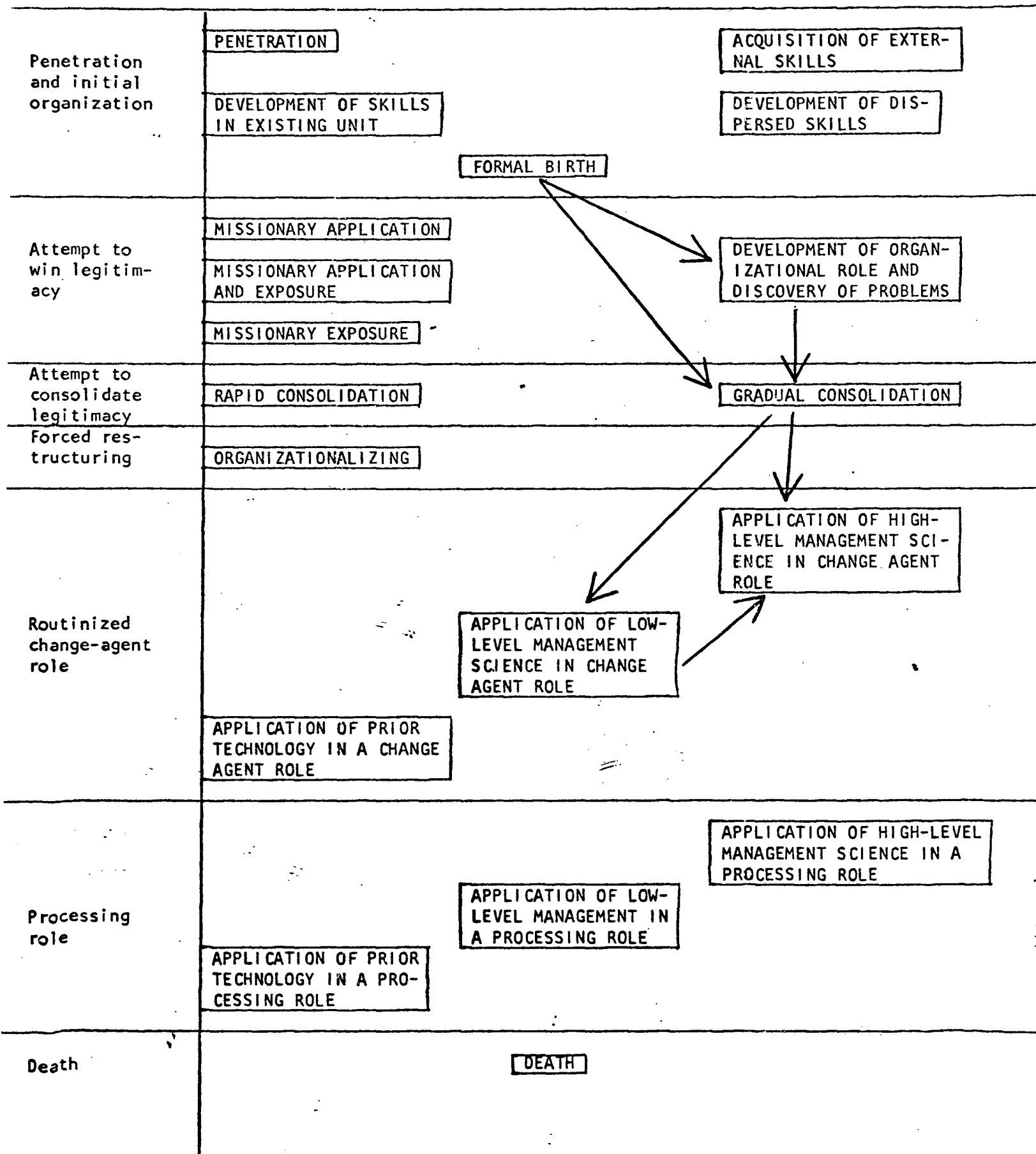




FIGURE 6: Two Examples of Mixed Patterns

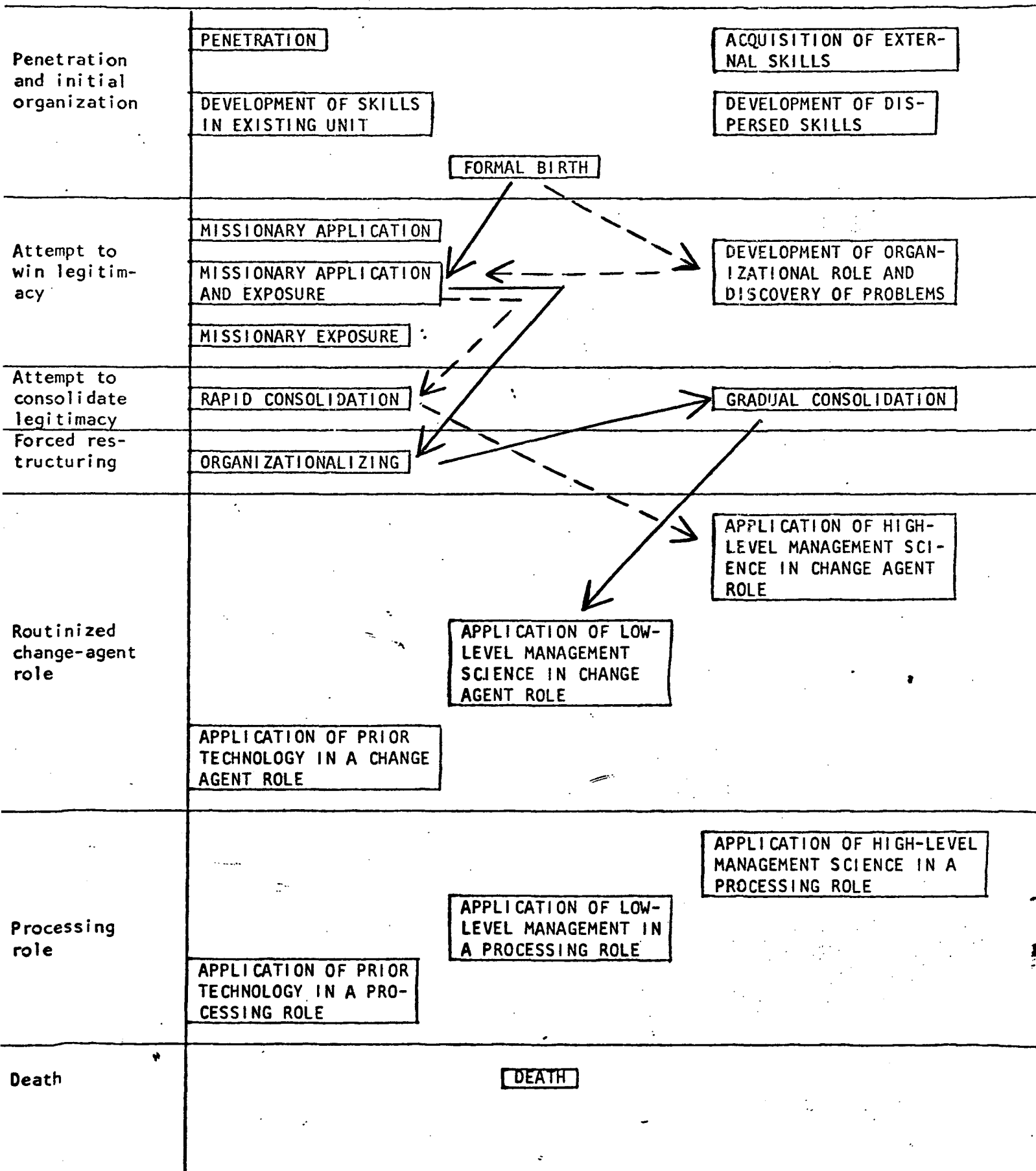


FIGURE 7: REVOLUTIONARY PATTERNS,

Beginning in a Missionary Phase

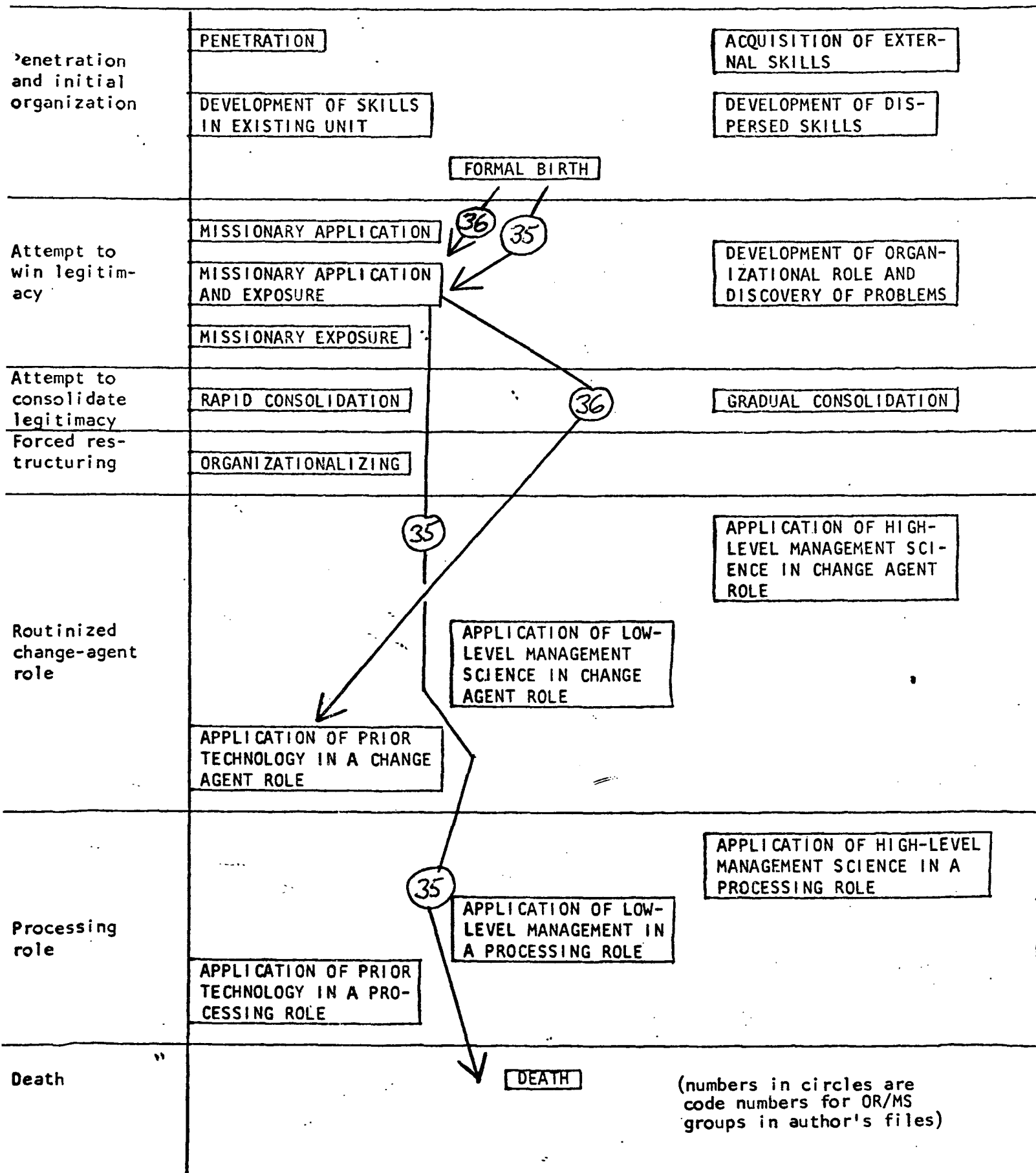
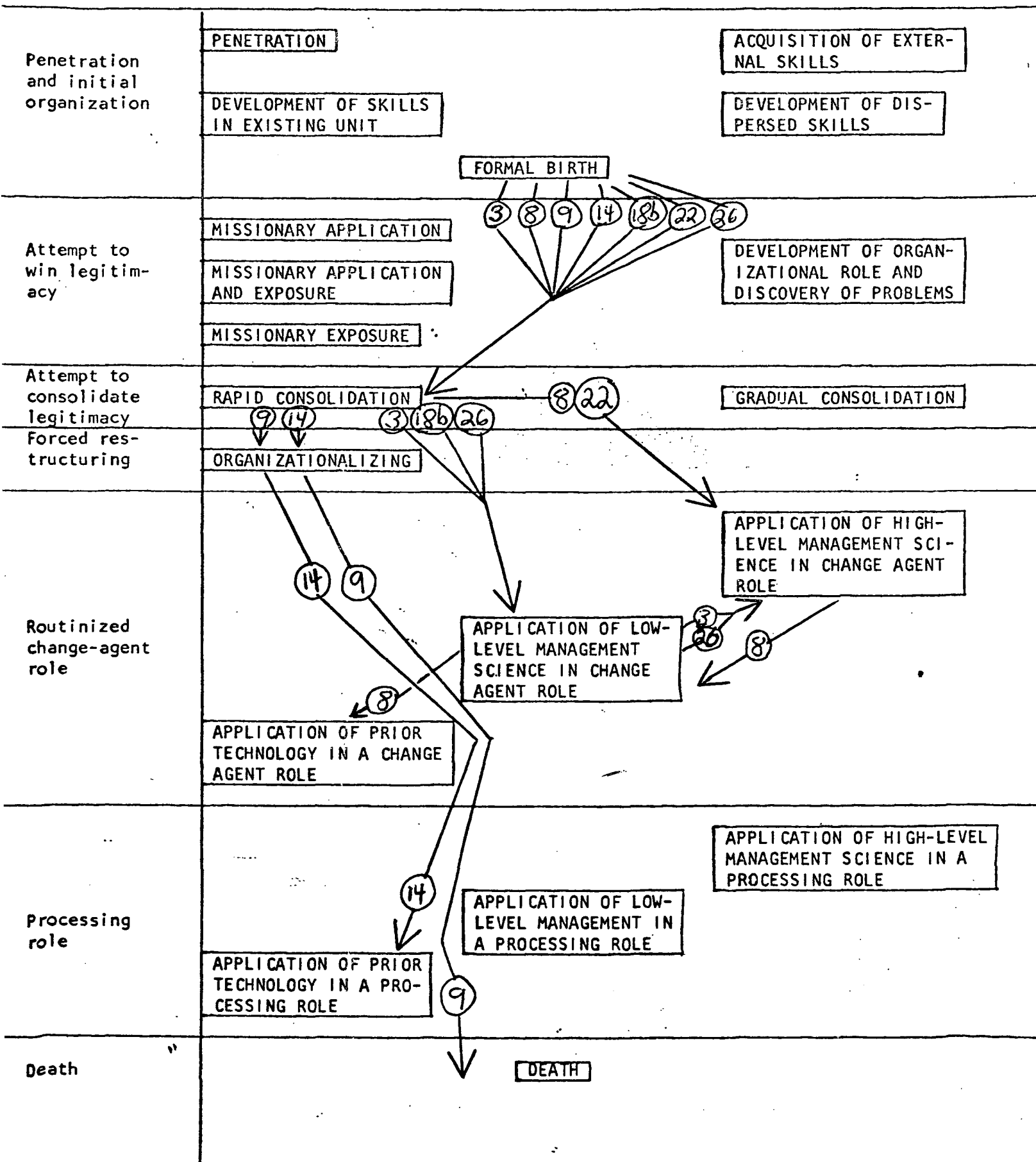


FIGURE 8: REVOLUTIONARY PATTERNS,  
Beginning in a Consolidation Phase



numbers 35 and 36, both make little progress through the model, and one of them dies. Seven groups begin their Revolutionary pattern in the Consolidation phase (Figure 8). Their current states range from Death (group number 9, which was disbanded a couple of years ago) to the Routine Application of High-Level OR/MS in a Change-Agent Role. The total number of Revolutionary groups is nine.

In Figure 9 are shown the seven Evolutionary groups which begin with an Attempt to Win Tentative Legitimacy phase. Several of these groups (File numbers 21b, 39) are still in the Consolidation phase. A couple have progressed to the Routinized Change Role phase, and the others have lost their OR/MS mission. Five of the six groups which begin in an Evolutionary pattern in the Consolidation phase have progressed to the Routinized Change-Agent Role phase with OR/MS technology; the sixth is a change-agent with pre-OR/MS technology (Figure 10). In all, there are thirteen groups which can be classified as Evolutionary. Combined with the nine Revolutionary groups, these two patterns include twenty-two of the thirty-three groups. From this first glance, then, the concept of Revolutionary and Evolutionary patterns seems a viable one.

There are also mixed patterns. These are shown in Figures 11 through 13. Seven of these eleven groups begin in a Missionary phase and show fairly simple patterns. These seven are presented in Figure 11. Five of the seven pass through Forced Restructuring phase, one of them twice. Two others, numbers 13 and 34, go directly from one of the

FIGURE 9: EVOLUTIONARY PATTERNS,

Beginning in a Phase of Attempting to Win  
Tentative Legitimacy

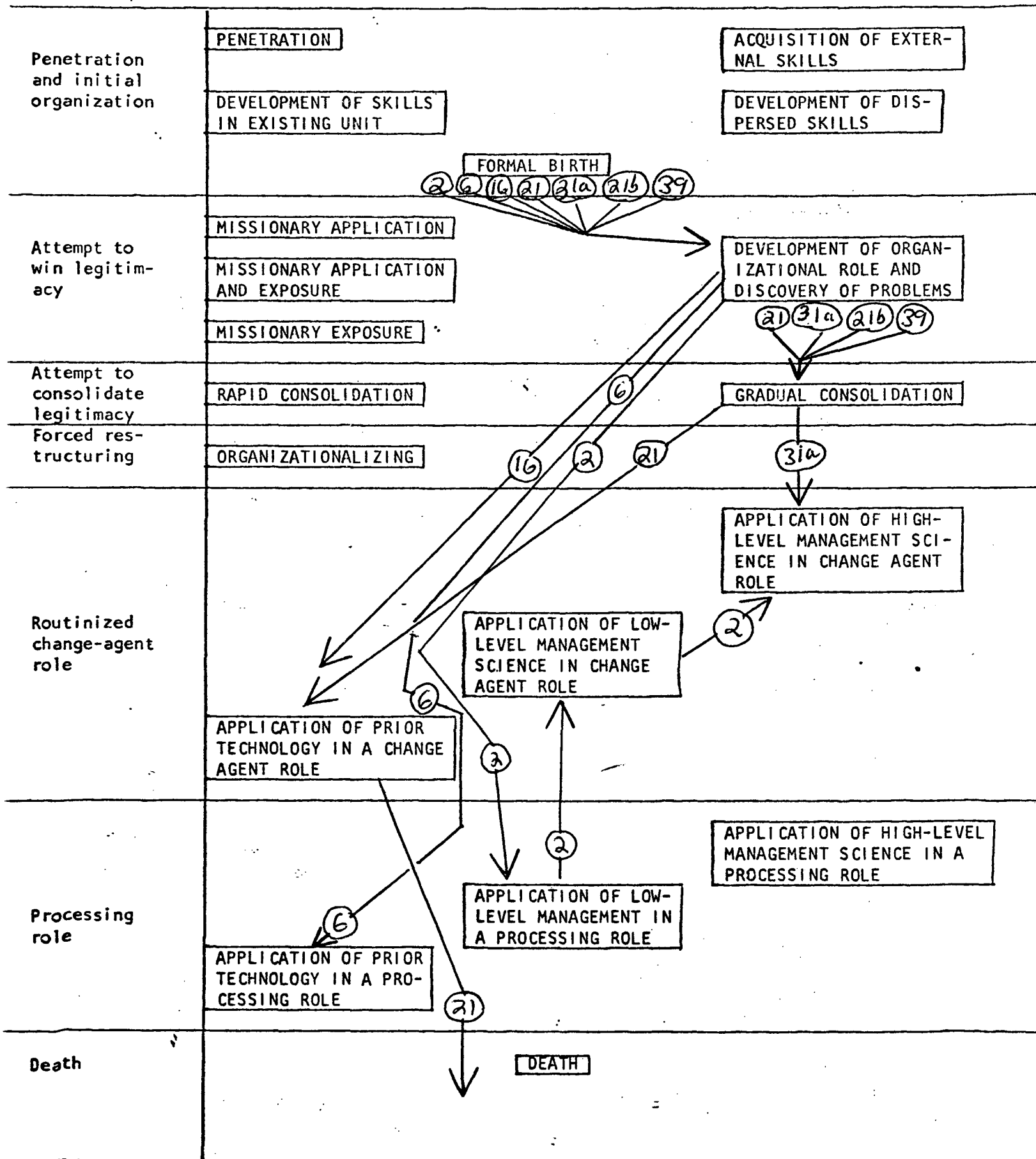


FIGURE 10: EVOLUTIONARY PATTERNS,

Beginning in a Consolidation Phase

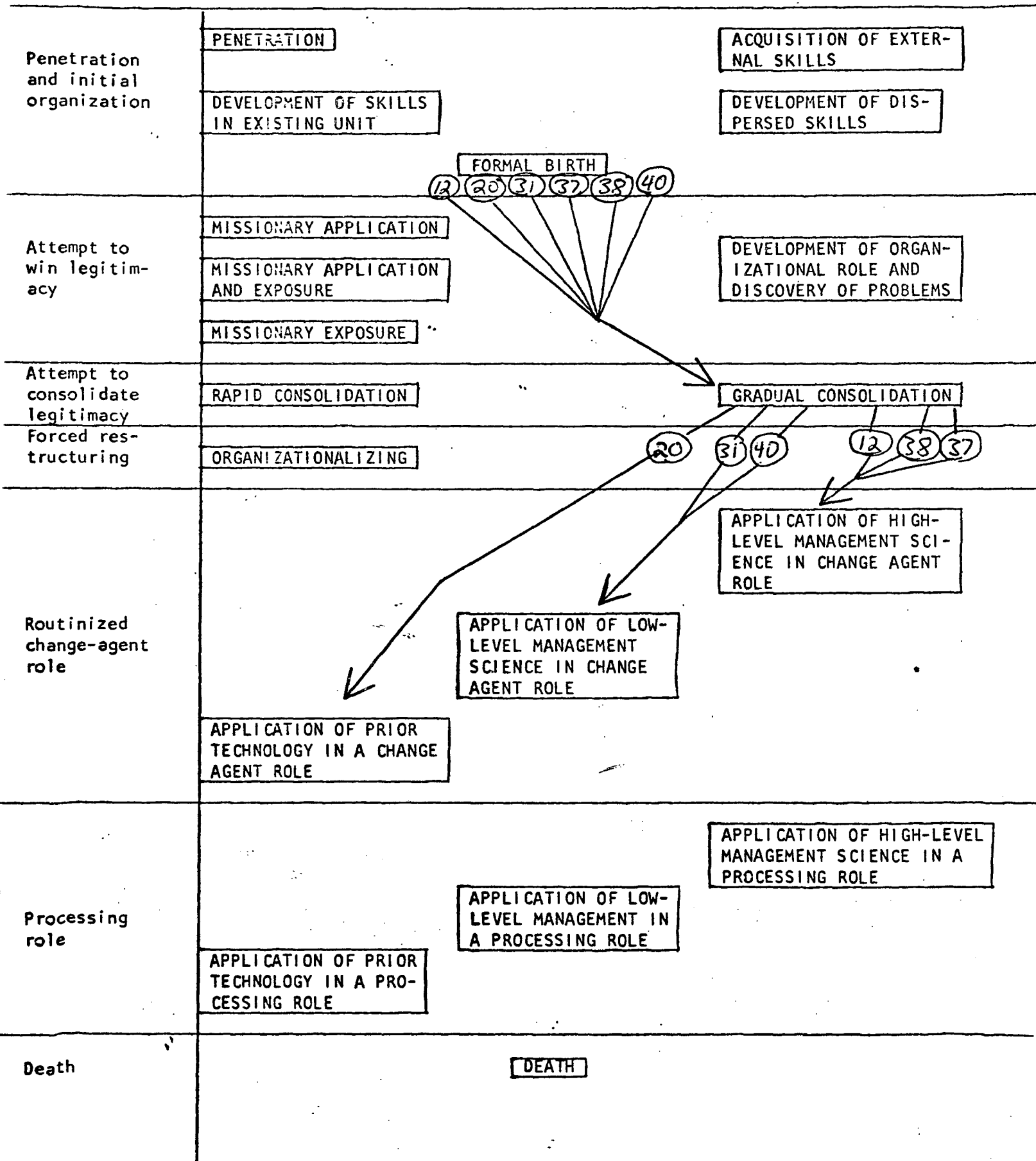
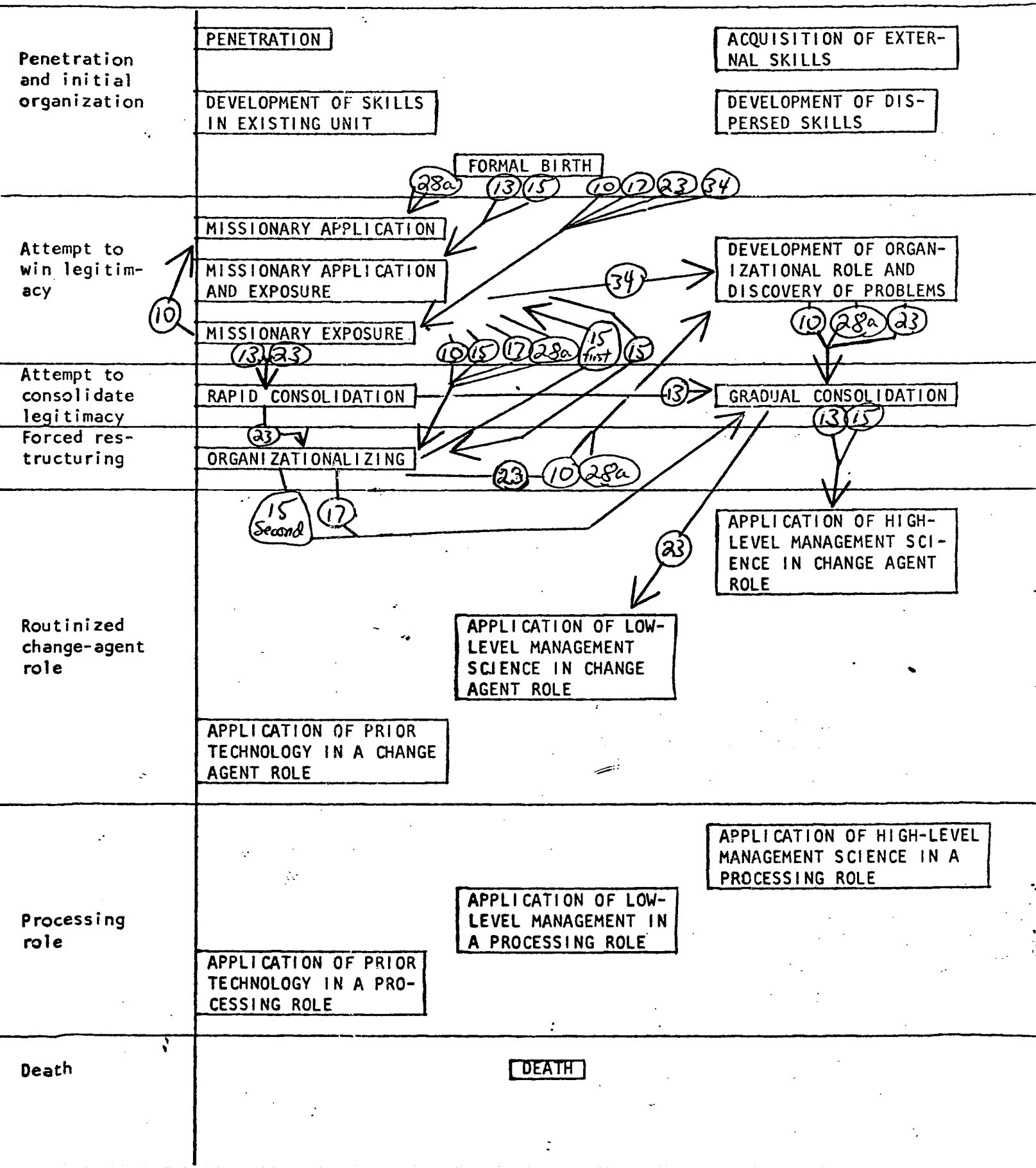


FIGURE 11: SEVEN MIXED PATTERNS,

Each Beginning in one of the Three Missionary Phases



characteristic Revolutionary phases to characteristic Evolutionary phases. Of the seven, three have progressed to the Routinized Change Role phase, three are still in a Consolidation phase, and one is still in the Evolutionary phase, Development of Organizational Role. In Figure 12 there is just one group, a mixed pattern beginning in the Consolidation phase, but passing through both Gradual and Rapid Consolidation. Finally, in Figure 13, there are three more complex mixed patterns. Groups numbers 1 and 19 are particularly complex, passing through six or seven phases each. Of the eleven groups in mixed patterns, nine begin with a Missionary phase, one begins with a Rapid Consolidation phase, and one begins in the Evolutionary pattern.

The dominance of the Revolutionary beginnings in the mixed pattern groups is important because it indicated the volatility of the groups that start with a Missionary phase. This point can be underlined by showing on one chart all the groups which begin with a Missionary phase. In Figure 14 the patterns for the eleven groups which begin with a Missionary phase are displayed. The diverse and unpredictable consequences of this phase are clear in the complexity of the figure. The eleven groups end up in six different phases, and only four of the groups end up practicing OR/MS technology in a Routinized Change Role. Of the four, the youngest group started in 1964, and none of them reached their present phase in less than six years. Yet the groups which began in the Rapid Consolidation phase do not show this volatility (Figure 8). Five of the seven reach a



FIGURE 12: A MIXED PATTERN,

Beginning in a Consolidation Phase

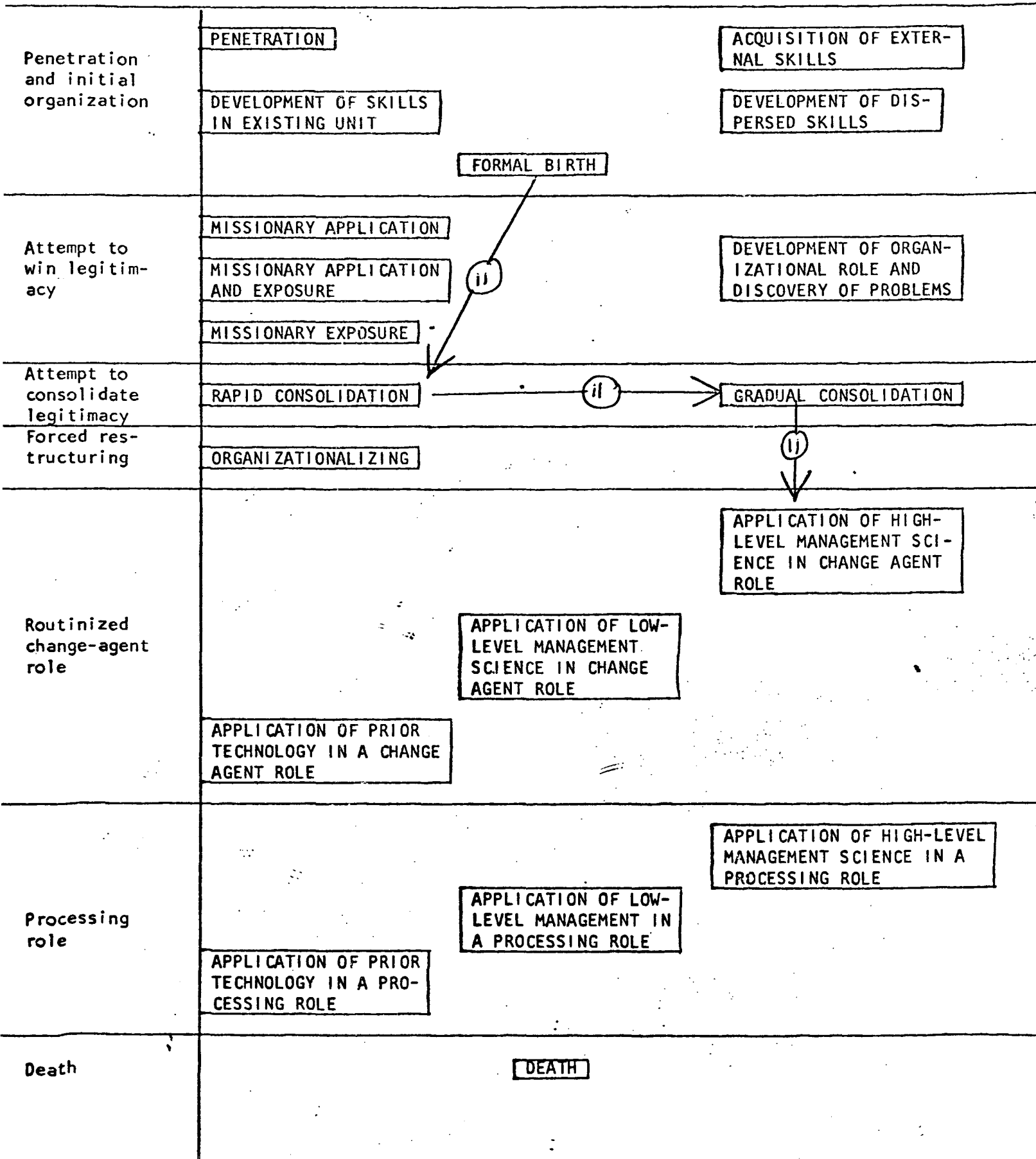


FIGURE 13: THREE ODD MIXED PATTERNS

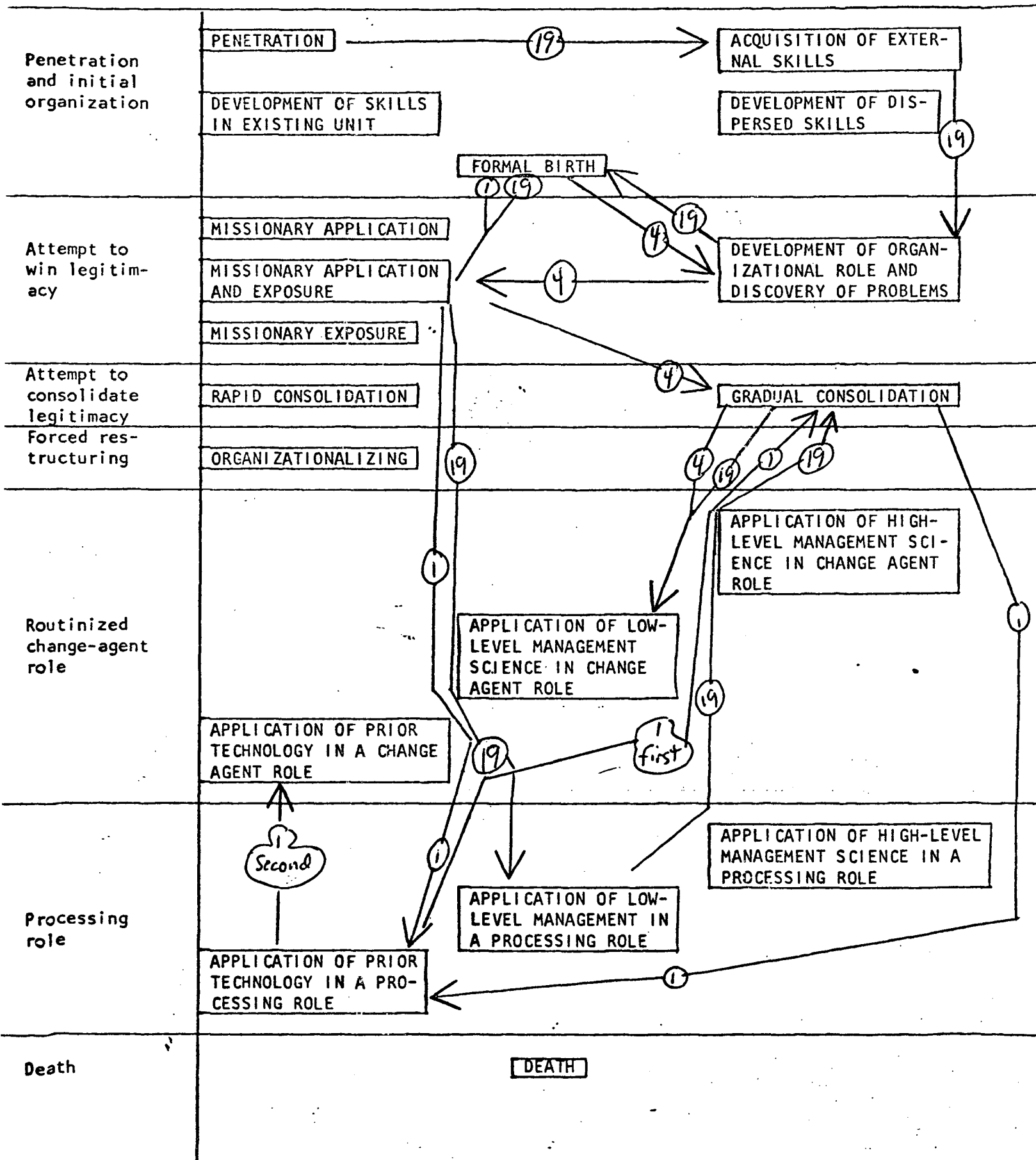
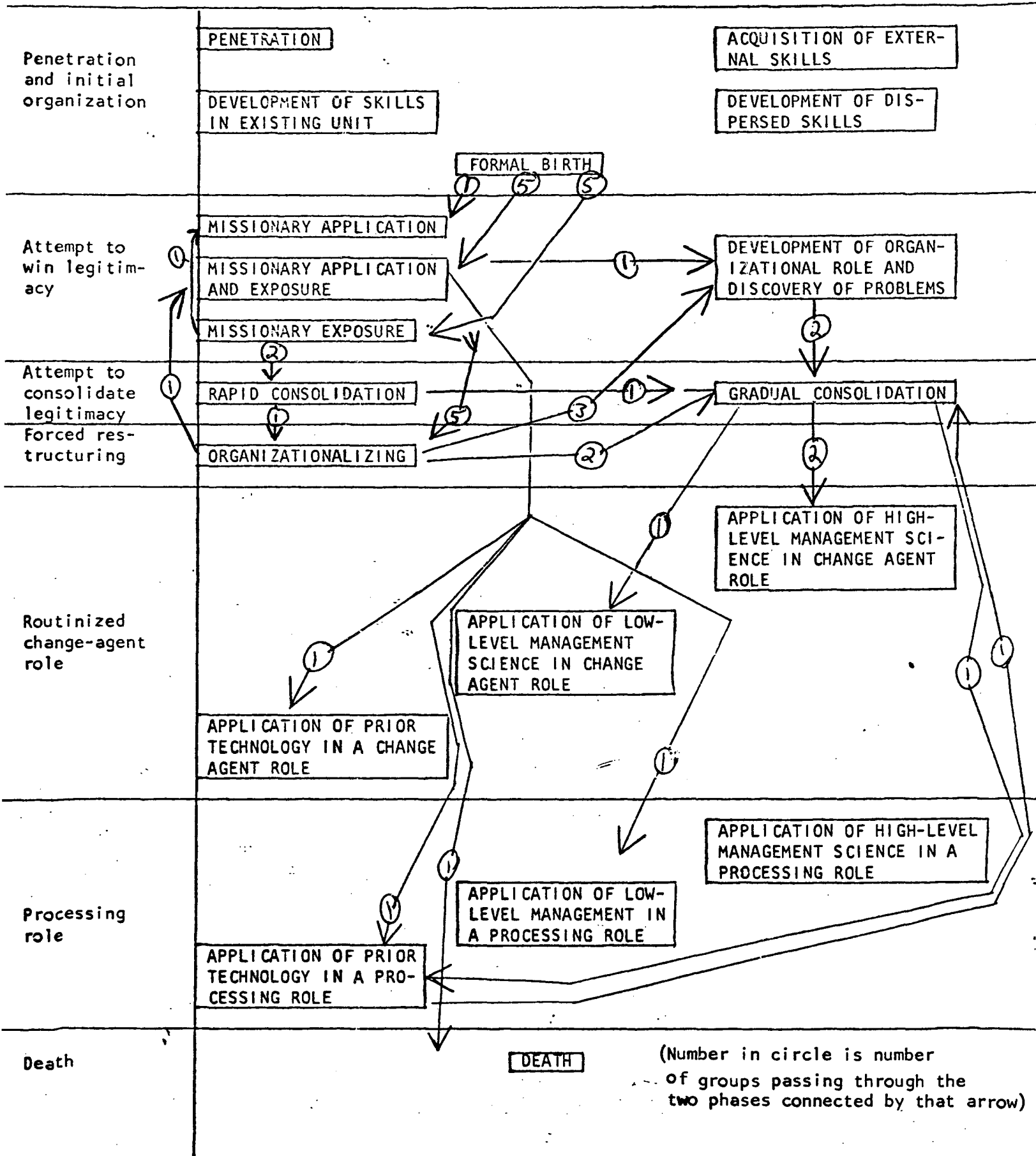


FIGURE 14: SUMMARY OF ALL THE GROUPS WHICH BEGIN IN A MISSIONARY PHASE.



Routinized Change Role phase with OR/MS technology, and each does it in less than four years. Admittedly, one of the five loses its OR/MS mission, but a new OR/MS group formed in this agency about the time that number 8 was declining. We are currently gathering data from this new staff.

Is there something special about the Missionary phase, or are the patterns followed by groups which begin as Missionary similar to the patterns followed by groups which begin in the Gradual Development phase? There are only seven Evolutionary groups which start in the Gradual Development phase, and two of the seven are relatively new (two or three years old). But three of the remaining five reach unimpressive ends. The two that reach a Routinized Change-Agent Role with High-Level OR/MS technology both take a long time to do that. One takes over ten years and the other about eight. So, although the evidence is scanty, it tends to suggest that it is the lack of legitimacy that is important, rather than the Revolutionary pattern or, more specifically, its Missionary phase.

● TENTATIVE LEGITIMACY AS A FACTOR IN THE DEVELOPMENT OF OR/MS

Three hypotheses might be offered at this point. Each of the three hypotheses proposes a different dichotomy as being most strongly related to the eventual fate of the OR/MS group:

1. Whether the group follows a Revolutionary, Evolutionary, or Mixed Pattern is most important.

2. Whether the group goes through a Missionary phase is most important. (Missionary --- non-missionary dichotomy)
3. Whether the group must pass through a phase of Attempting to Win Tentative Legitimacy is most important .  
(Tentative -- Consolidation Dichotomy)

The first of these distinctions has already been explored at length. The second compares groups that begin in a Missionary phase, whether they follow a Revolutionary Pattern or a Mixed Pattern, with all other groups. The third distinction is between groups that begin in either a Missionary or a Gradual Development phase and groups which start in the Rapid or Gradual Consolidation phases, regardless of the pattern they ultimately follow. This is equivalent to distinguishing groups which begin without tentative legitimacy and groups which begin with tentative legitimacy but have not yet consolidated it; hence, the shorthand term, tentative-consolidated dichotomy. Two measures of the eventual fate of the group can be used:

1. Whether the group reached a phase of Routine Application of OR/MS in a Change Agent Role. As a shorthand, the attainment of such a phase will be called "success" of the OR/MS groups.
2. How long it took the group to reach this phase.

The Evolutionary, Revolutionary, and Mixed Patterns are roughly comparable in terms of the frequency with which groups in each of these patterns have reached the Routinized Change Role phase. The major

difference is in the number of groups ending in Processing or Death phases rather than in early phases. Here, only Revolutionary groups end up in Processing or Death (see Figure 15). In terms of the number of years that it takes to reach a phase of Routine Application of OR/MS in a Change-Agent Role, there are notable differences. The Revolutionary groups reach these phases in 1.8 years on the average (Figure 16) while the Evolutionary groups average 4.3 years, and the Mixed groups average almost six years. The Revolutionary pattern has implications for the speed at which a group can make it to a Routinized Change Agent phase with OR/MS technology. But, there seems to be a cost for this speed; in the Revolutionary pattern, groups are more likely to end up extinct or in a Processing Role phase. In the Evolutionary and Mixed patterns, several groups still exist in early phases and thus still have the chance to reach a Routinized Change-Agent role phase.

The Missionary phase distinguished with some strength among groups in terms of their early 1971 phases. It is clear from Figure 17 that if the phase of Routine Application of OR/MS in a Change-Agent Role is defined as success, then Missionary groups are less successful. If we are specially concerned with the application of high-level OR/MS, the distinction is heightened considerably.

In terms of the number of years it takes to reach a Routinized Change-Agent Role with OR/MS phase, non-missionary groups are about twice as quick, 3.2 years versus 6.4 years (Figure 18). The numbers are similar if high-level and low-level OR/MS are distinguished. The Missionary

FIGURE 15  
Phases, January, 1971\*

GROUP FOLLOWS	High-Level OR/MS in Change-Agent Role	Low-Level OR/MS in Change-Agent Role	Prior Technology in Change-Agent Role	Processing or Death	Earlier Phases
EVOLUTIONARY PATTERN	5 (38%)	2 (15%)	2 (15%)	-0-	4 (31%)
REVOLUTIONARY PATTERN	4 (44%)	1 (11%)	1 (11%)	3 (33%)	-0-
MIXED PATTERN	3 (27%)	3 (27%)	1 (9%)	-0-	4 (36%)

In the case of Group No. 8, the highest phase reached has been recorded here instead.  
\*%: ages may not add to 100 due to recoding.

FIGURE 16

GROUP FOLLOWS	% of groups following this pattern that reach a phase of Routine Application of OR/MS in a change-agent role.	Average number of Routine Application of high-level OR/MS in change-agent role	Years to reach Routine Application of low-level OR/MS in change-agent role	Routine Application of any level OR/MS in change-agent role
EVOLUTIONARY PATTERN	54%	5.4 (n=5)	3.7 (n=3)	4.3 (n=7)
REVOLUTIONARY PATTERN	56%	2.2 (n=4)	1.7 (n=3)	1.8 (n=5)
MIXED PATTERN	55%	6.0 (n=3)	5.3 (n=3)	5.7 (n=6)

FIGURE 17

GROUP FOLLOWS	High-Level OR/MS in Change-Agent Role	Low-Level OR/MS in Change-Agent Role	Prior Technology in Change-Agent Role	Processing or Death	Earlier Phases
GROUPS PASS THROUGH MIS-SIONARY PHASE	2 (18%)	3 (27%)	2 (18%)	1 (9%)	3 (27%)
GROUP DOES NOT PASS THROUGH MISSIONARY PHASE	10 (44%)	3 (14%)	2 (5%)	4 (18%)	3 (14%)

FIGURE 18

GROUP FOLLOWS	% of groups following this pattern that reach a phase of Routine Application of OR/MS in a change-agent role	Average number of Routine Application of high-level OR/MS in change-agent role	Years to reach Routine Application of low-level OR/MS in change-agent role	Routine Application of any level OR/MS in change-agent role
GROUP PASSES THROUGH MIS-SIONARY PHASE	45%	8 (n=2)	5.3 (n=3)	6.4 (n=5)
GROUP DOES NOT PASS THROUGH MISSIONARY PHASE	59%	3.8 (n=10)	2.7 (=6)	3.2 (n=13)



phase is not as powerful a discriminator as the Revolutionary pattern on this index, however.

The Tentative/Consolidation distinction is clearly the most powerful. Almost 70 percent of the groups which begin with tentative legitimacy and thus can start in a Consolidation Phase manage to reach a phase of Routine Application of OR/MS in a Change-Agent Role (see Figure 19). Only about 45 percent of the other groups have made it through the model to those phases. The length of time it takes to reach such phases also differs most dramatically across the Tentative/Consolidation distinction. Here, the figures are 2.2 years versus 7.1 years, a difference of better than a factor of three (Figure 20). With respect to the length of time it takes to reach a phase of Routine Application of High-Level OR/MS in a Change-Agent Role, the difference is greater than a factor of four.

Overall, it is clear that the Tentative/Consolidation distinction is the most powerful. The superiority of this distinction is enhanced by the fact that second place on the two measures is split by the other two distinctions (see the summary in Figure 21). It may be worthwhile to maintain the distinction between Revolutionary and Evolutionary patterns, but this distinction has a less clear implication than the author originally thought.

#### THEORIES OF CHANGE VERSUS THEORIES OF CHANGING

In spite of the fact that the Tentative/Consolidation distinction discriminates most powerfully between successful and less successful

FIGURE 19

GROUP FOLLOWS	High-Level OR/MS in Change-Agent Role	Low-Level OR/MS in Change-Agent Role	Prior Technology in Change-Agent Role	Processing or Death	Earlier Phases
GROUP BEGINS IN PHASE OF ATTEMPT TO WIN <u>TENTATIVE</u> LEGITIMACY	4 (24%)	3 (18%)	3 (18%)	3 (18%)	4 (24%)
GROUP BEGINS IN PHASE OF ATTEMPT TO <u>CONSOLIDATE</u> TENTATIVE LEGITIMACY	8 (50%)	3 (19%)	1 (6%)	2 (12%)	2 (12%)

FIGURE 20

GROUP FOLLOWS	% of groups following this pattern that reach a phase of Routine Application of OR/MS in a change-agent role	Average number of Routine Application of high-level OR/MS in change-agent role	Years to reach Routine Application of low-level OR/MS in change-agent role	Routine Application of any level OR/MS in change-agent role
GROUP BEGINS IN PHASE OF ATTEMPT TO WIN <u>TENTATIVE</u> LEGITIMACY	41%	9.5 (n=4)	5.0 (n=4)	7.1 (n=7)
GROUP BEGINS IN PHASE OF ATTEMPT TO <u>CONSOLIDATE</u> TENTATIVE LEGITIMACY	69%	2 (n=8)	2.4 (n=5)	2.2 (n=11)

FIGURE 21

	1971 Phases	Length of time it takes to reach any phase of Routine Application of OR/MS in change-agent role
EVOLUTIONARY/ REVOLUTIONARY/ MIXED DISTINCTION	Little difference (third place)	Revolutionary groups are faster by a factor of 2.5 or 3 (second place)
MISSIONARY/ NONMISSIONARY DISTINCTION	Nonmissionary groups reach a phase of Routine Application of OR/MS in a change-agent role about 30 percent more often. (second place)	Nonmissionary groups are faster by a factor of 2 (third place)
TENTATIVE/ CONSOLIDATION DISTINCTION	Consolidation groups reach a phase of Routine Application of OR/MS in a change-agent role about 75 percent more often (first place)	Consolidation groups are faster by a factor of better than 3 (first place)

OR/MS groups (measured by the frequency with which groups of either category reach the Routinized Change-Agent Role with OR/MS, and by the length of time it takes to reach that phase), this finding is not of great utility to the practicing manager. Given this distinction, he may desire to measure the readiness of his organization to accept OR/MS. If precise measurement is needed, there are tested scales that might be adapted for this purpose (Likert, 1967; Duncan, 1971). The resulting data can warn the manager that he faces difficulty in introducing OR/MS but it cannot guide his tactics. For a more useful finding, the Revolutionary/Evolutionary or Missionary/Non-Missionary distinctions can be employed. While the a priori climate for OR/MS is not under the immediate control of the supervisor, sponsor, or leader of an OR/MS group, the missionary character of the group can represent a conscious design decision.

Being missionary, or more generally, revolutionary, involves controllable variables such as:

- (a) the professional competence of the OR/MS analysts;
- (b) the technical level and organizational impact of the OR/MS projects;
- (c) the number of clients pursued and the vigor with which they are pursued;
- (d) the way in which projects are defined;
- (e) the amount of review and control exercised by clients and higher managers over the OR/MS staff;
- (f) the amount of time the OR/MS group devotes to formal projects rather than quick servicing or "fire-fighting."

Each of these variables is potentially under conscious control of someone in the organization, and together they can be manipulated to regulate the social and technical aggressiveness of the OR/MS group in accordance with the regulator's interpretation of organizational possibilities.

The salience of these controlable variables can be illustrated by examining the leaders of Evolutionary and Revolutionary groups. While academic degrees are not necessarily an adequate index of a person's skill or professional commitment, it remains that there is a striking difference in the level of education of the leaders of these two types of OR/MS groups. Most of the nine Revolutionary groups are led by Ph.D.s, and none, for which data was available, have less than a master's degree with a number of years of experience. The one person for whom we have no precise data does possess an advanced degree and prior to becoming a group leader he had spent several years as a key member of a Missionary OR/MS staff (see Figure 22). Only three of the thirteen Evolutionary groups are led by people with Ph.D.s and four others are led by people with a master's degree in an OR/MS related discipline (O.R., statistics, micro-economics). One leader has some advanced degree but of distant vintage and uncertain discipline; six others have either no formal OR/MS training or training limited to such courses as one might obtain in an M.P.A. program. The mixed pattern groups are not included in Figure 22. Of these eleven groups, several move from Revolutionary to Evolutionary Phases at the same time as there is a leadership change, but most of these groups are led by people with Ph.D. degrees or master's degrees and considerable OR/MS experience.

**FIGURE 22: OR/MS TRAINING OF THE LEADERS OF  
REVOLUTIONARY AND EVOLUTIONARY  
OR/MS GROUPS**

		Group follows:	
		Revolutionary Pattern	Evolutionary Pattern
Group leader has:	PhD. in an OR/MS field	5	3
	Master's in an OR/MS field	3	3
	No advanced OR/MS training	0	6
	Training not known	1	1

The Revolutionary/Evolutionary distinction, then offers a basis for a theory of changing, as distinct from a theory of change (Bennis, 1966), a theory in which the key variables are chosen for their accessibility to managerial manipulation rather than for their statistical significance or paradigmatic (kuhn, 1962) relevance.\* The fact that the Tentative/Consolidation distinction discriminates more powerfully between successful and less successful groups than does the Revolutionary/Evolutionary distinction is consistent with the intuitive notion that theories of changing will have less predictive power than theories of change. The advantage of a theory of changing is that it can be implemented, not that it is more adequate in the abstract.

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\*The difference between theories of changing and theories of change is nicely illustrated by the following passage from Ann Douglas' Industrial Peacemaking (Columbia University Press, 1962; p. 162):

In one of its feature "Profiles" The New Yorker honored the head tone regulator for Steinway concert grand pianos, William Hupfer. The tone regulator's job is the testing of hammer felts for variations of tonal quality, in distinction to that of a piano tuner, who concentrates on pitch. Hardness in felts is corrected by jabbing them with needles; tired felts are rejuvenated by filing off worn grooves. Hupfer is quoted in this bit of musing about his unusual occupation:

Now, I will admit that the effect of the felts on tone is a small thing compared to all the other influences. Most of your tone, of course, is built right into the instrument. It's not just the sounding board but the entire piano, down to the smallest screw, that vibrates, and that's what sets up the sound waves. Even the stage of the concert hall vibrates with the piano, so you have to count that in, too. Well, the felts are just one part of the whole thing, but you can't do anything about all the rest of it unless you want to go out and start from the beginning and build yourself a completely new piano. The felts are the one part you can change. When you look at it that way, they are very important.

ORGANIZATION THEORY AND THE RELEVANCE OF OR/MS TO GOVERNMENT

The distinctions among the patterns followed by OR/MS groups in their development in government organizations highlight another issue. The relevance of OR/MS to government policy-making has in the past been treated in terms of:

- (a) the supposedly special characteristics of such policy-making (Mosher, 1970; Wildavsky, 1964);
- (b) the different political characteristics of policy arenas (Schultze, 1969); or
- (c) some vaguely normative criteria.

These arguments easily turn into predictions of success or failure for OR/MS (White, 1971b). But here it can be seen that the success and failure of OR/MS can also be conceived as depending on matters of strategy in the introduction of OR/MS vis-a-vis the agency's climate for change. The implications of this conclusion are sizable, for public administration as a discipline has tended to be preoccupied with the outer ranges of its possible concerns, administrative detail and broad-ranging normative and policy matters. The middle range of explicit analysis of individual and group behavior has been handled at best by borrowing of concepts and findings from research in nongovernmental organizations. Normative questions are not circumvented by the kinds of findings presented here; rather, all that is claimed is that these kinds of findings make it more difficult to argue behavioral conclusions (e.g., the possibility or impossibility of OR/MS) from normative premises (e.g., democracy is better realized when there is a free play of selfish interests unhampered by technocratic analysis).



### THE IMPACT OF PPBS ON THE GROWTH OF OR/MS

Further insight into the development of OR/MS in government can be obtained by shifting the level of analysis. Rather than looking at the OR/MS groups in an organization, look at OR/MS groups in government as an aggregate phenomena. Figure 23 displays the phases of the 33 groups at the end of each year from 1960 to 1970. By arranging the data in this way, rather than on phase diagrams (Figures 7 through 13), the progress of OR/MS in the federal government through the 1960s can be discussed.

One thing immediately obvious from Figure 23 is that OR/MS in civilian government is not a child of PPBS revolution. By the end of 1965, 14 of the 33 OR/MS activities were already on the chart, and none of these were responses to the PPBS revolution. Most of those that reached a Routinized Change Role phase by then or within the next three years were independent of PPBS. Thus while PPBS received much attention in the academic community and precipitated debate over the relevance of OR/MS in civilian applications, at the pragmatic level, the debate had begun long before.

However, equally obvious is that the two years following the pronouncement of PPBS were singularly important for the development of OR/MS in civilian agencies. Half of the OR/MS groups in this sample (16 of 31) were initiated in 1966 or 1967. Not all of these groups were the direct result of an attempt to initiate PPBS activities. Many, on the contrary, had their origins in internal agency developments (8, 11, 12, 18a, 34). It seems reasonable, then, to assume that PPBS for the civilian

FIGURE 23

	'60	'61	'62	'63	'64	'65	'66	'67	'68	'69	'70
Missionary Exposure			17	17	17,23	17	35	34,35	35,36	35,36	
Missionary Application and Exposure			15	1,15	1,15	15,19					
Missionary Application						10	28a	4			
Gradual Development	2,31a	2,31a	31a	31,31a	21,31a	21	4,10	10,16,23	10,16,28a, 21b,23,34	28a,21b, 34,39	34,39
Rapid Consolidation	13,14	14	14,22	14,22	14,22	14,23, 26	8,9,11, 23	3,9,11, 18b	18b		
Gradual Consolidation		13	13	13	13	13,31a	1,12,15, 19,21,40 31a,38, 17	15,17,19, 20,31a,21 37,40 28a	4,15,17,19 20,21,37, 40	10,17,28a, 21b,23	
Organizationalizing								8,12,13, 22,26,38	2,11,12,13 31a,22,26 38	2,11,12,13, 15,31a,22, 26,38 38	2,3,11,12,15, 31a,22,26,37, 38
High-Level Management Science in Change-Agent Role						22	13,22				
Low-Level Management Science in Change-Agent Role					2	2	2,26	2	3,8	3,4,8,19, 40	4,18b,19,31,40
Prior Technology in Change-Agent Role									21	1,16,20,21	1,8,10,20,36
High-Level Management Science in Processing Role											
Low-Level Management Science in Processing Role			2	2							
Prior Technology in a Processing Role	6	6	6	6	6	1,6	6,14	1,6,14	1,6,14	6,14	6,14
Death									9	9	9,21,35
Don't Know								31			
TOTAL GROUPS ACTIVE AT END OF YEAR	5	5	8	11	12	14	23	30	32	33	33

End of the year phases for the groups: Numbers are surrogates for the names of the groups; chart allows reader to follow the progress of individual group over the years.

agencies appeared at a propitious time, a time when many agencies were ready to try some form of OR/MS. If that is the case, then PPBS was not forced from above upon a group of unprepared and uninterested agencies. Rather, though there were certainly some agencies bound to be lagging the trend, PPBS for many agencies represented an alternative way of approaching something they already intended to do. An example to illustrate this conclusion is the Agriculture Department which had already tried one cycle of zero-based budgeting (Wildavsky and Hammann, 1965) and before the PPBS pronouncement was in the process of planning some similar activity. The rapid success of some of the new OR/MS groups initiated in 1966 and 1967 reinforces the hypothesis that many agencies were "ready." Group Nos. 8, 3, 12, and 38 are cases of ready agencies, compared with Nos. 34 and 35, for example.

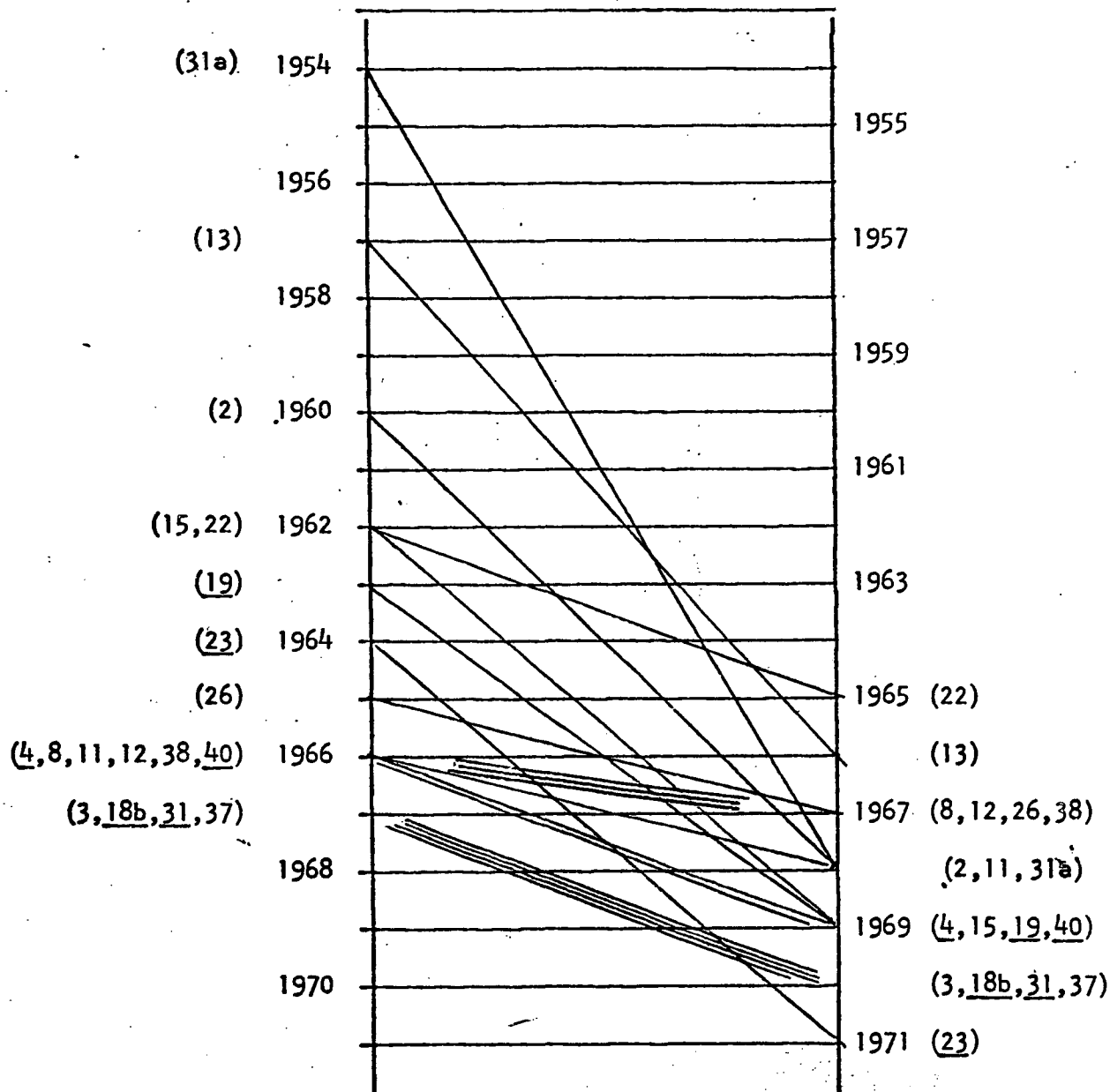
Over the years covered by Figure 23, definite progress in the integration of OR/MS into federal civilian agencies is evident. The number of groups in the phases of Routine Application of either Low or High Level OR/MS in a Change-Agent Role increases from one in 1964 to seven in 1967 and up to 15 in 1970. These 15 groups are in 15 separate agencies in six cabinet departments and several independent offices. Without raising the question of whether these groups are working on "really important problems" (for the definition of this term tends to move with the expanding influence of OR/MS), the data presented in Figure 23 indicate that the impact of OR/MS in federal civilian agencies is increasing steadily.

HOW LONG DOES IT TAKE AN OR/MS STAFF TO DEVELOP?

One reason for this increasing impact is simply that there are more OR/MS groups around and thus more of them which are influential or successful. Undoubtedly this is so. At the same time, there is some evidence that the length of time that it takes for an OR/MS group to develop is itself decreasing. If that is so, then the influence of OR/MS in government should grow faster than the increase in number of OR/MS groups. Figure 24 indicates that the situation is not entirely unambiguous. The figure presents those groups which have reached a phase of Routine Application of OR/MS in a Change-Agent Role. It is clear that early OR/MS groups took a long time to reach these phases. Six to eight years is common for groups beginning before 1966. In recent years, for those groups which have reached these phases, the time has diminished considerably. Three years is a modal period. Yet, as can be seen from Figure 24, several of the groups which were initiated around 1966 took even less time than three years. So, although the overall movement is one of compression in the development time of OR/MS groups, there was one period when this compression was exaggerated. Before inquiring as to why this was so, it is necessary to qualify this data.

Figure 24 represents only some of the groups which started in each year. One cannot know for sure how those groups which have not yet reached a Change-Agent Role phase will affect the trends observable in Figure 24. However, as one can see in Figure 25, little change in the

**FIGURE 24:** The Length of Time it Takes OR/MS Groups to Reach a Phase of Routine Application of OR/MS in a Change-Agent Role.

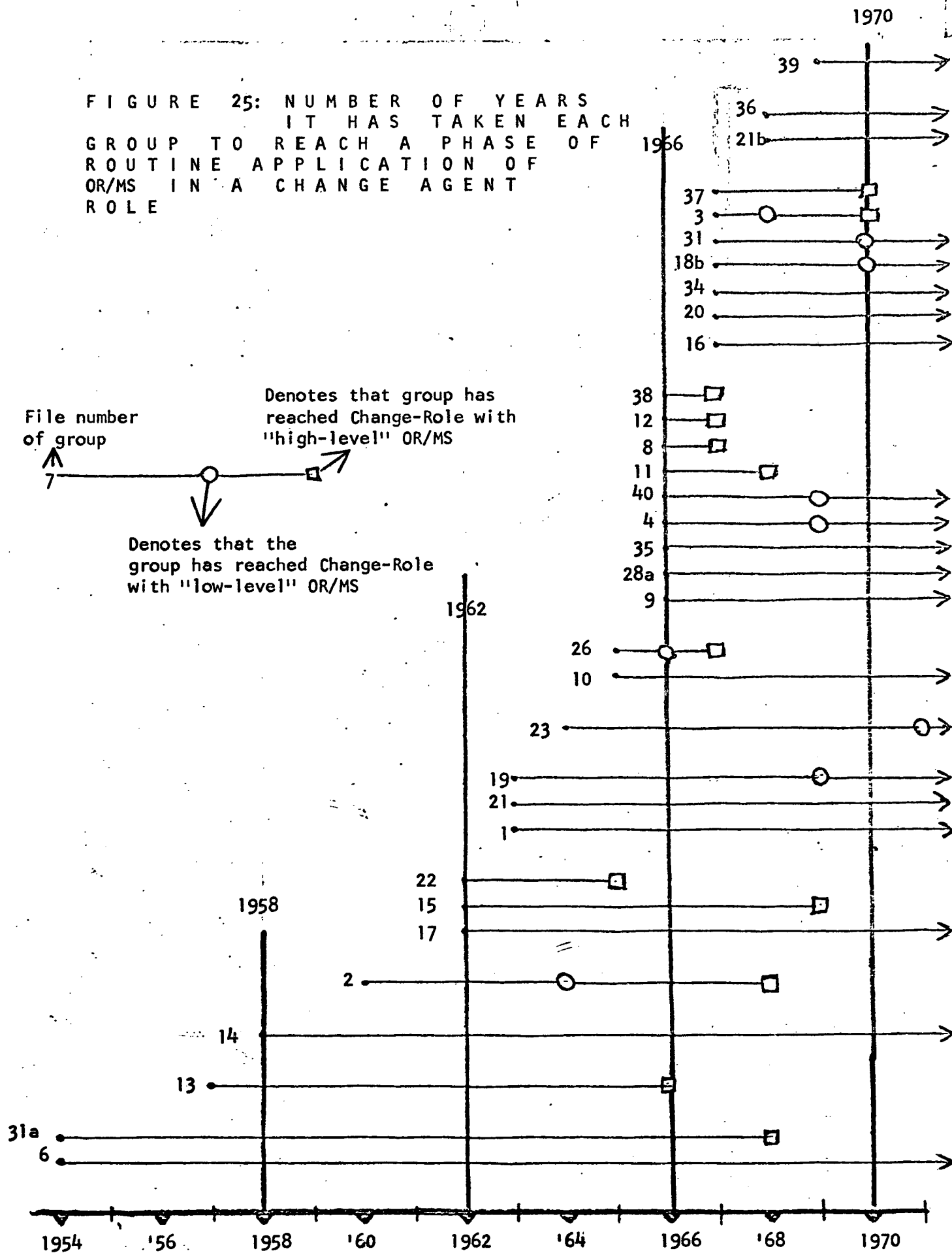


The year a group begins is noted in the left column; the year it reached the Change Agent Role with OR/MS is noted on the right column. Where the group's file number is underlined, that indicates that the group has only reached the Change Agent Role with "low-level" OR/MS. Otherwise, the number in the right column indicates when the group reached the Change Agent Role with "high-level" OR/MS.

broad conclusion can be anticipated. Six of the nine groups which began in 1966 are included in Figure 24 and two of the three remaining ones have been disbanded. Groups begun in 1967 not only take a little longer to develop to the Change-Agent Role phase, but also, three out of seven, rather than three out of nine (as in 1966) have not reached those phases yet. But groups starting in those two years show clear evidence of faster development times than earlier groups. Several of the groups begun in earlier years have also not yet reached a Change-Agent Role phase with OR/MS.

The compression of development time evident in Figures 24 and 25 might be explained in several ways. One way is through a hypothesis of social learning. Over the years, managers have learned to manage OR/MS more smoothly as experience with it has accumulated and been disseminated in management journals, seminars, and conferences. At the same time, OR/MS analysts have learned through their personal experiences, and through the transmission of these experiences to students in formal OR/MS programs, how better to "succeed" in an organizational setting. At the same time, it might be argued that over the years there has been an increasing need for OR/MS as organizations have grown larger and more complex, and as their environment has become more densely populated with competitive forces. Consequently, managers perceive a greater need for OR/MS and are more ready to grant it a trial. Similarly, there has clearly been an increase in the number of people available to do OR/MS both in an in-house capacity and as consultants. This greater availability, combined with the refinement and

FIGURE 25: NUMBER OF YEARS IT HAS TAKEN EACH GROUP TO REACH A PHASE OF ROUTINE APPLICATION OF OR/MS IN A CHANGE AGENT ROLE



elaboration of OR/MS so that it is a technology applicable to an expanding number of problems, might also explain the compression in development time. There is no data available for a direct test of any of these hypotheses. However, some evidence of an increase in the perceived need for OR/MS, and for an increased a priori acceptance of it based on social learning, might be gained from examining whether new groups begin in Tentative or Consolidation phases. Figure 26 shows by calendar year, in which type of phase new groups begin. Except for 1966 and 1967, new groups tend to begin in a Tentative phase. But in 1966 and 1967, ten out of sixteen groups -- the early phase of one group is unknown -- begin in a Consolidation phase.

Earlier, we found that beginning with a Consolidation phase meant that the group would probably develop very rapidly (Figures 19 through 21). Placing the incidence of this type of beginning in a longitudinal context helps explain the compression of development time presented in Figures 24 and 25. At the same time, it lends credence to the suggestion that some form of social change favorable to OR/MS has taken place. There is little in this data, however, to indicate why groups beginning in 1966 develop even faster than groups beginning in 1967. The subsample is too small to pursue empirical analysis of this point.

There remain to be studied a number of OR/MS groups which began in 1968 or later. Several of these are currently under investigation. Therefore, it seems premature to conclude from Figure 26 anything more than that there is a trend in recent years for new OR/MS groups to begin in a Consolidation pattern. It is the author's suspicion that the most receptive agencies have in fact been "mined" and that those remaining



FIGURE 26: GROUPS BEGINNING EACH YEAR,

DIVIDED INTO THOSE BEGINNING IN TENTATIVE  
AND THOSE BEGINNING IN CONSOLIDATION PHASES

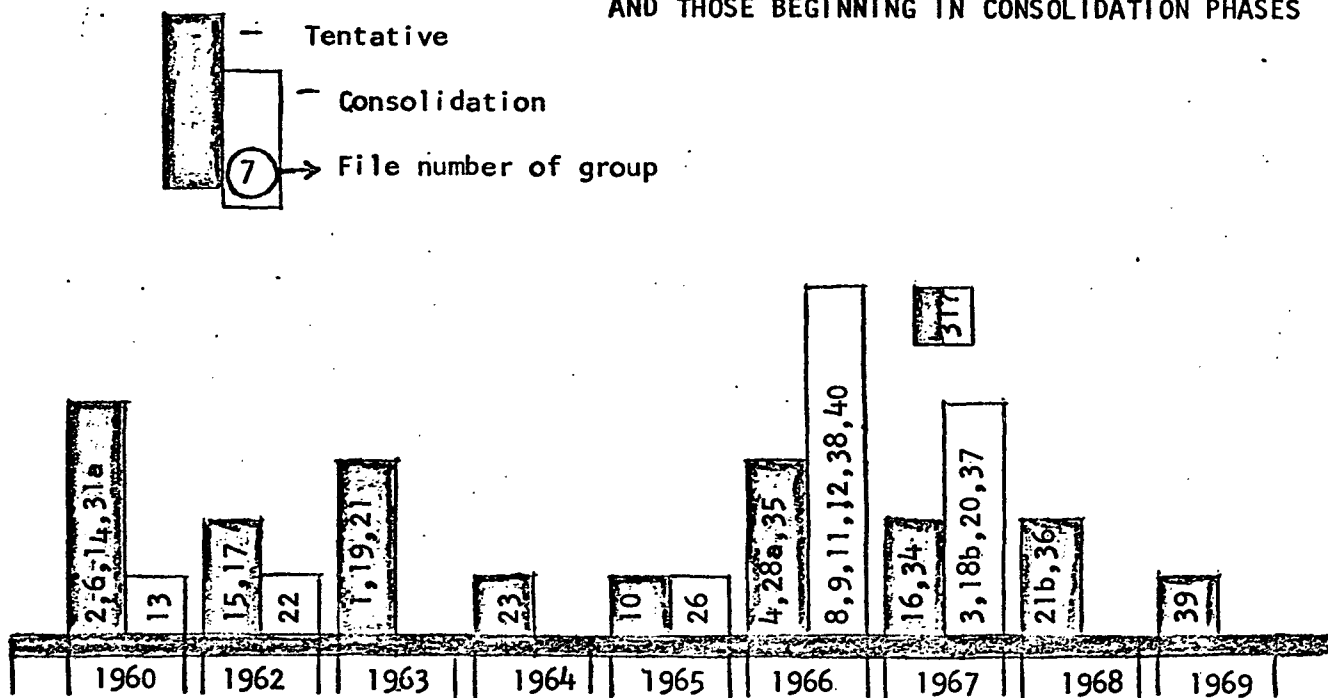
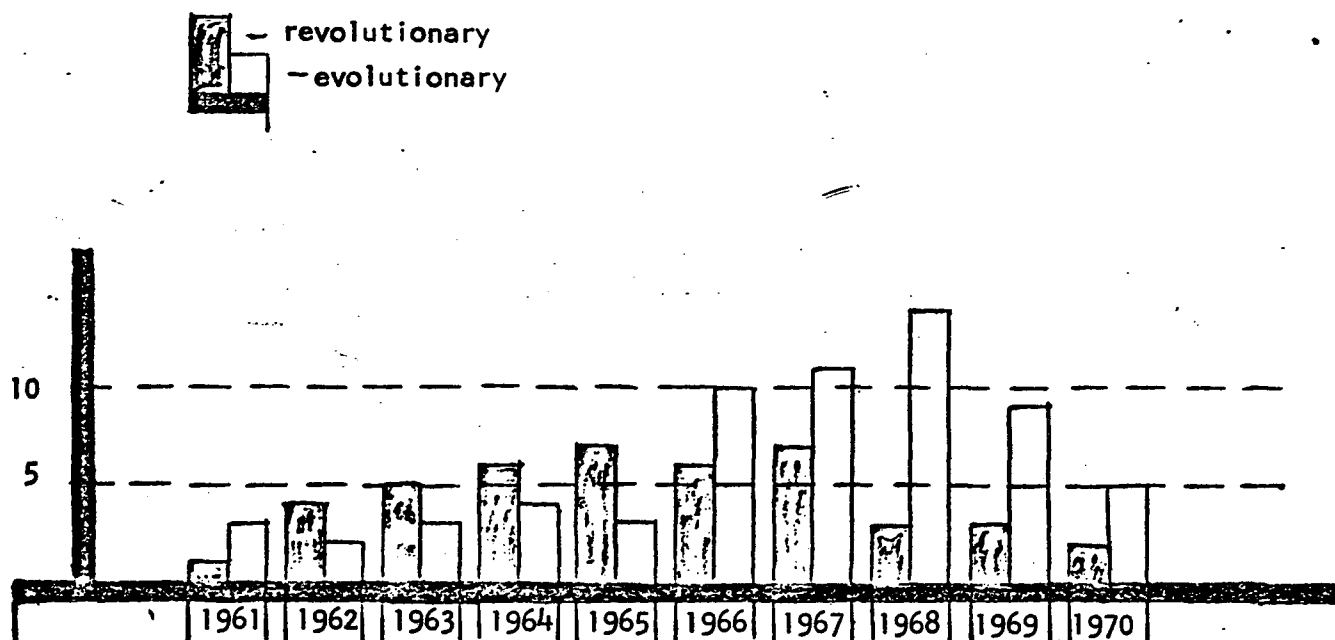


FIGURE 27: NUMBER OF GROUPS IN REVOLUTIONARY  
AND EVOLUTIONARY PHASES, BY YEAR,

1961 -- 1970



without OR/MS after 1967 were agencies presenting greater obstacles to the development of OR/MS. However, this suspicion cannot be verified for several more years. The fact that three groups in the sample which beginning after 1967 all began in a tentative phase is not sufficient to support the contention, thus it remains a suspicion.

#### EVOLUTIONARY AND REVOLUTIONARY PATTERNS IN LONGITUDINAL PERSPECTIVE

In an earlier paper, in which there was a preliminary unverified coding of business and government OR/MS on an earlier version of the phase model, the author found that the Revolutionary and Evolutionary patterns oscillated over time in their relative incidence (White, 1969). During the first five years in which OR/MS was to be found with any frequency in U. S. businesses, more groups were each in Evolutionary than in Revolutionary patterns (from 1950 to 1955). In the next five years, more groups assume Revolutionary patterns (1956 to 1960) and after that, the Evolutionary pattern is more frequent again. The same alteration was found in federal civilian agency OR/MS groups, except with a lag of five years. It seemed appropriate, then, to examine the recoded and verified data to see if this alteration would again emerge. If this alternating pattern were confirmed, it would increase our understanding of the integration of OR/MS into a class of organizations.

Figure 27 reveals in tabular and graphical form that between 1962 and 1965 groups were more likely to be in Revolutionary phases (if they were in either characteristically Revolutionary or characteristically Evolutionary phases any year). But from 1966 to 1970, the frequency

reverses and each year more groups were in characteristic Evolutionary phases. Prior to 1962, the combined frequencies are small and have not been included. The same was the case in the earlier analysis, but that data was used then anyway. In this exposition, the data is not considered sufficient for the years before 1962 to derive any conclusion. However, after 1961, the data is clear: groups are more often Revolutionary in the early 1960s and more often Evolutionary in the latter half of the decade.

This finding itself is of interest; perhaps it represents a need for aggressive activity if the new change function is to penetrate a new set of institutions. If so, then the change to Evolutionary patterns may indicate social learning in the direction of minimizing conflict and increasing the probability of survival. More importantly however is the finding itself vis-a-vis critical reaction to OR/MS. Much of the critical reaction to OR/MS in government may be seen to stem from early periods in which aggressive behavior was most characteristic of OR/MS analysts. The critical reaction lags behind actuality by several years, given the time required for study, writing, and publication. Thus, it was not until the latter part of the decade that the criticisms of OR/MS based on the excesses of the early and mid-1960s could appear.

If the experience of OR/MS in federal civilian agencies is at all representative of new managerial technologies in institutional environments (e.g., large U.S. corporations, federal civilian agencies) in general, then there may be some important lessons here. First, the

aggressiveness, overselling, and disappointments characteristic of the early years of OR/MS in civilian government may be unavoidable. If this is so, then it behooves us to see these Missionary phenomena as functional. Perhaps they serve necessary attention-getting and unfreezing functions within a given class of organizations or institutional environments. Also, these phenomena may serve a recruiting function, helping attract students into the new specialty. Finally, the Missionary activities may also serve to keep up morale of the carriers of the new technology at a time when they face many obstacles to their trade and have few successes to their credit. The frequency with which stories of early OR successes are repeated (such as ship convoys or gas blending) suggests this interpretation. The second lesson concerns the criticisms of OR/MS and related technologies. If these are in fact something which tend to be based on out-of-date experiences, then we can assume that the profession in its own activities is likely to be ahead of criticisms. Yet managers in a given class of institutions are more likely to read the external critics of the profession and its technology than they are the internal critics. Managers may therefore form opinions of the new technology based on outdated criticisms which reinforce their natural resistance to threatening change. These considerations lead to the conclusion that it is in the self-interest of the new professionals to make their internal disputes and criticisms more available to the managers for whom they wish to work.

## SUMMARY

This paper offers diverse findings regarding the organizational aspects of the development of OR/MS. On the one hand, it offers findings about the way an OR/MS staff develops in an individual case; on the other, it offers findings and speculations about the development of OR/MS in an institutional environment (U.S. federal civilian agencies).

Regarding the development of individual OR/MS staffs, it is found that the concepts of Revolutionary and Evolutionary patterns are viable distinctions. Although the distinction between groups starting in a Tentative or Consolidation phases (without or with Tentative Legitimacy) is statistically stronger, the Evolutionary/Revolutionary distinction, and the similar Missionary/Non-Missionary distinctions, offer a basis for a "theory of changing" regarding the introduction of OR/MS or other new management technologies into government (or other) organizations. Also, the distinctions discussed and their relation to the rate and outcome of the group's development, emphasize a fundamental argument of this research: that the development of OR/MS in government must be viewed as an issue in organizational behavior, and not just as an issue of normative preference or political theory and practice.

The data have also allowed some inquiry into the aggregate development of OR/MS in the institutional environment of federal civilian agencies. It is noted, however, that formally organized in-house OR/MS is only part of all the OR/MS activity in federal agencies. Examination of the number of OR/MS activities existing in each year of the past decade

reveals that PPBS, often seen as a major impetus to the adoption of OR/MS in the civilian agencies, and equally often seen as an unwanted intrusion, perhaps arrived at a propitious time. Many new OR/MS activities began, in 1966 and 1967 but only some of these are directly related to PPBS. Rather, given the character of the development of OR/MS in the previous years, it seems more reasonable to conclude that PPBS was a catalyst that speeded up adoption, and influenced the nature, of OR/MS in organizations that were likely on the verge of adopting some form of OR/MS anyway.

At the same time, there is some evidence that the length of time it takes an OR/MS group to develop to maturity (the Routine Change-Agent Role phase) has decreased over the years. Thus the impact of management science on government increases not only because the number of OR/MS groups has increased but also because these groups in recent years have developed to a position of influence more rapidly. The reasons for this compression of development time are not entirely clear. Hypotheses of social learning and increased environmental pressure are entertained. Data is available to sharpen speculations. Recently initiated groups, for example, tend to begin in a Consolidation phase, shown earlier to be associated with rapid development. Likewise, there appears to be a longitudinal oscillation in the relative frequency of the Revolutionary and Evolutionary patterns. This finding has implications, particularly for the way managers, analysts, and scholars interpret criticisms of OR/MS.

Although the data presented in this paper are diverse, they all serve to emphasize the primary point: If we desire to understand the develop-

ment of OR/MS in government organization, we must see it as a problem in empirical organization theory and not just as a problem in normative or speculative analysis.

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